ICSCEA 2023

Proceedings of the Third International Conference on Sustainable Civil Engineering and Architecture

19–21 July 2023 | Muong Thanh Luxury Da Nang Hotel, Da Nang City, Vietnam

J. N. Reddy
Chien Minh Wang
Van Hai Luong
Anh Tuan Le *Editors*

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Foreword

On behalf of the Organizing Committee, we are delighted and honored to extend a warm welcome to all of you to the Third International Conference on Sustainable Civil Engineering and Architecture 2023 (3rd ICSCEA 2023). The conference is organized by the Faculty of Civil Engineering at Ho Chi Minh City University of Technology (HCMUT), Vietnam National University - Ho Chi Minh City (VNU-HCM), and is sponsored by Ho Chi Minh City's Department of Science and Technology (DOST) and Vingroup Innovation Foundation (VINIF).

Held biannually, ICSCEA provides a platform for scholars in Civil Engineering and Architecture from Vietnam and around the world to share their ideas, exchange knowledge, connect with one another, and contribute towards building a better world through science and technology.

The conference will be held over two and a half days in the beautiful city of Da Nang and it will feature two plenary lectures, three keynote lectures, and more than 200 technical paper presentations in eight designated fields of civil engineering and architecture. There will be six sets of onsite parallel sessions, as well as an online parallel session and a technical tour. We are excited to bring together experts in the field to share their knowledge and insights. We would like to express our sincere gratitude to the plenary speakers, keynote speakers, and participants for their valuable support. We hope that the knowledge and experience shared and discussed during this conference will pave the way for effective developments in future academic and practical collaborations.

We sincerely appreciate the efforts of the Organizing Committee, the International and Local Scientific Committees, and all participants who contributed to the success of this conference. We would also like to thank the national and worldwide reviewers for their invaluable assistance in reviewing the submitted abstracts and papers.

Finally, we would like to express our sincere thanks for your valuable contributions to the 3rd ICSCEA 2023. Thank you for your onsite and online attendance. We greatly appreciate your engagement and support for future ICSCEA events.

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Plenary Lectures

Computational Modeling of Architected Structures and Fracture in Solids

J. N. Reddy

TEES Center of Innovation in Mechanics for Design and Manufacturing

J. Mike Walker '66 Department of Mechanical Engineering

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Abstract. The lecture will present the speaker's continuing research in nonlocal approaches for modeling architected materials and structures [1] and a graph-based finite element analysis (GraFEA) of fracture [2, 3]. The non-local continuum models that account for material and/or structural length scales are discussed to model architected materials and structures (e.g., web-core sandwich panels) using the micropolar elasticity. The GraFEA is built upon the fact that the finite element formulation for any hyperelastic continuum can be written in terms of the forces and strains along the edges of the elements. The major difference between GraFEA and continuum-based approaches such as the cohesive-zone models and XFEM to study fracture is that instead of placing the focus on the elements and introducing a displacement discontinuity either between or inside the elements, GraFEA focuses on nodes and the distance between the nodes. Fracture is merely introduced by breakage of the edges (a link between any two distinct nodes). Consequently, it will not suffer from the drawbacks of the existing continuum-based methods in the study of fracture. Use of the GraFEA to study fracture in solids is found to be very robust and accurate in predicting fracture. The computational technique also incorporates a probabilistic approach to damage growth by using a measure of "microcrack survival probability" and its evolution. The usefulness of these approaches will be demonstrated using several nontrivial examples.

Acknowledgements: The author gratefully acknowledges the research collaboration on GraFEA with Drs. Arun Srinivasa and Prakash Thamburaja. The author also gratefully acknowledges the support of this work, in parts, by the National Science Foundation grant (award number 1952873) and the US Army (ERDC Contract #W912HZ19C0042).

References

1. Anssi Karttunen, J.N. Reddy, and Jani Romanoff, Int. J. Solids and Structures, 170, 82-94, 2019.
2. P. Thamburaja, K. Sarah, A. Srinivasa, and J. N. Reddy, Proceedings of the Royal Society A, 477, No. 2252, 2021.
3. H. Y. Shin, P. Thamburaja, A. Srinivasa, and J.N. Reddy, Extreme Mechanics Letters, 52, article 101618, 2022.
4. H. Y. Shin, Prakash Thamburaja, Arun Srinivasa, and J.N. Reddy, Journal of the Mechanics and Physics of Solids, 170, article 105097, 2023.

Advances in Research and Developments on Offshore Aquaculture and Renewable Energy Production

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Abstract This paper is concerned with advances in research and developments on offshore aquaculture and renewable energy production. We first discuss the motivation and challenges for moving offshore in these two blue industries. This is followed by a summary of recent advances and research needs in offshore fish farming, seaweed cultivation, and harvesting energy from offshore wind, solar, wave and tidal current.

Keywords: offshore aquaculture, renewable energy, fish farming, offshore wind energy, tidal current energy, solar energy, wave energy

An Investigation of Smart City Development Implementation in Korea: Barriers, Potential and Future

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Abstract. The implementation of smart city development projects faces numerous barriers that hinder progress and require effective policies and strategies. This study examines the barriers encountered in innovative city development in Korea based on existing literature, including lack of political support, insufficient external financial support, limited cooperation, physical and environmental characteristics, technological limitations, social factors, financial constraints, and political challenges. The development of smart cities in Korea often focuses on idealized visions of the future, overlooking the complexities of existing urban environments. To address these barriers, the study proposes strategies based on Korea's experience, such as large-scale collaboration, component sharing, instilling a culture of innovation, and integrating information and communication technologies (ICTs). Examples of ongoing smart city projects in Korea, like the Sejong 5-1 Living Area and the Incheon Free Economic Zone, highlight the importance of transportation design, crime prevention, and smart tourism. The study acknowledges that smart city construction is a global trend and recognizes developing countries' unique challenges. Understanding these challenges is vital for promoting successful smart city development globally. Overall, the study provides insights into the barriers to smart city development in Korea and offers strategies to overcome them, contributing to the discourse on smart city development and providing implications for policymakers, urban planners, and researchers in the field.

Keywords: Smart city, Korea, ICTs, Innovation.

Structural Isolation Control: From Base to Inter-Storey and Hybrid Systems

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Abstract. This talk discusses the comparison on inter-storey isolation (FPS-I) strategy versus base isolation (FPS-B), as well as their combinations namely hybrid system, for structural vibration control against earthquakes and various dynamic loads. Both experimental verifications and computational analysis for the isolation systems utilizing friction pendulum are studied. A scaled 9-storey experimental model structure is constructed in accordance with the third generation Benchmark problem, and three types FPS with different slideway radius configurations are designed and manufactured based on the geometric similarity criterion. To assess the dynamic characteristics of FPS-B structure and FPS-I structure, four ground motions and four different intensities of peak ground acceleration (PGA) are considered. The findings show that FPS-I can effectively suppress the superstructure's acceleration as well as affecting the lower substructure's response. When the same earthquakes occur, the vibration reduction effect of FPS-I strategy is remarkable, which is obviously superior to FPS-B scheme. The FPS-I technology is observed to have an even greater effectiveness on the entire structure's vibration reduction during strong earthquakes than the traditional FPS-B technology. The basic mode as well as the higher-order mode responses of the high-rise structure can be controlled, resulting in the seismic response of the entire FPS-I structure at lower levels. The first-order mode contributes the most to the superstructure's floor acceleration response. The location of the isolation layer changes the dynamic characteristics of the structure substantially. This research emerges the benefits of FPS with inter-storey isolation to address the issue of high-rise structures being prone to be overturned in the case of base isolation.

Keywords: high-rise structure, friction pendulum system, base isolation, inter-storey isolation, shake table test

Sinkhole Detection, Analysis, and Repair

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Abstract. Sinkholes can be formed by human activities such as underground mining, tunnelling, and underground utilities pipes in urban areas. Occurrence of sinkhole and roadway depressions can result in serious issues such as lane and road closures, disruptions to the public's usual way of life, and loss of assets and human lives. On 11th February 2020, burst water main on Ann Street in Brisbane's Fortitude Valley is causing significant peak hour traffic delays, and on 14th June 2021, a fire truck has become stuck in a sinkhole on Juliette Street in Greenslopes after the road caved in. These two recent events highlight the importance of sinkhole detection, analysis, and repair. This keynote lecture aims to explore the feasibility of developing a portable drone mounted GPR based experimental study, to develop advanced numerical models for analysis of the sinkhole problem, as well as to develop sinkhole repair guideline and design options to sinkhole repair options. The outcomes of this project will reduce the road related sinkhole risks to many civil engineering infrastructures.

Keywords: sinkhole detection, analysis, and repair

Architecture Session

A Tale of Exploring Saigon's Morphology and Architecture in 1954-1975

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Abstract. Saigon had been well known as the key economic center in the south of Vietnam from the 17th to the 20th centuries, over historical periods (Pre-Gia Dinh, Gia Dinh, French colony, Americanised Saigon) [1]. After the unification of North and South Vietnam in 1975, it has been renamed Ho Chi Minh City, which faces urbanization, and globalization in the last decades. There is very little evidence as considerably as a research gap of Saigon's heritage resources during the Americanised period (1954-1975) due to political unrest at that time. The paper aims to explore the status of local historical heritages (urban and architectural constructions) under US involvement, which fostered the English language to be quite popular in the South of Vietnam. This structure of discourse developed is based on literature review, newspaper cutting, and survey methods to understand physical changes in city morphology, urban form [2], architectural language, and infrastructure in Saigon. Its findings figured out remaining construction that are invaluable in a different view towards a completed plan of preserving local heritage with particular historical value. Several suggestions are raised for a sustainable Ho Chi Minh City in globalization.

Keywords: Saigon, American war, city morphology, architectural language, discourse.

Adaptive Spatial Structure of Urban System to Drought and Flood Coexistence (DFC) in Ninh Thuan Province, Vietnam

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Abstract. Climate Change (CC) has increasingly influenced our planet and cities in recent decades. Global researchers have changed their viewpoints regarding the city. The notion of Resilience, particularly of resilient cities to the CC, has been developed since then and has attracted significant attention and interest in the planning practice. Among the natural disasters caused by CC, drought and flood have emerged and coexisted in the centre of Vietnam, especially in the cities of Ninh Thuan province. However, the study of the provincial cities shows that their spatial structure has changed over time and has caused many contradictions with the natural conditions. This study aims to restructure urban spatial systems to help them be more adaptive to nature, drought, and flood. The study covers four sections: (i) Introduction, ii) Methodology and methods, iii) Study context and results, and (iv) Conclusion. The first section introduces general information about Ninh Thuan province and its drought and flood coexistence (DFC) status. The second one proposes the methodology and methods, focusing on mapping Ecological Services (ES) relevant to DFC in the province area. The specific attention of the paper, introduced in the third part, is to examine the transformation of Ninh Thuan cities' spatial structure over time, based on the ES map, to restructure it to be more adaptive to DFC. The study concludes in the fourth with a suggestion that urban spatial systems could be structured to be more adaptive to DFC in correlation with urban development on a sustainable pathway.

Keywords: adaptive city, adaptive urban spatial structure, adaptive spatial structure to drought and flood coexistence (DFC), ecological services (ES)

Restructuring of Large Urban Planning in Vietnam in Accordance with the Green Corridor Theory, with Hanoi City as A Research Area

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Abstract. Vietnam experiences a period of strong urbanization, it is found to be difficult to control the development of large cities, leading to serious problems such as lack of housing, overloaded infrastructure and environment pollution. The establishment of large urban structure is still based on traffic structure and land use, which is not suitable for typical conditions of Vietnamese cities. In particular, the theory of green corridor planning has successfully applied many cities in the world and has many similarities with the natural framework of Vietnamese cities. The article researches on the current situation of planning structure of a number of large cities in Vietnam, from a proposal of urban planning restructuring model in Vietnam in accordance with the theory of green corridor planning and applying it to Hanoi city.

Keywords: large city(ies), restructuring, planning, green corridor, Hanoi city.

An Analysis of Corporate Social Responsibility Implementation in Architectural Design Firms Towards Sustainable Development

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Abstract. Due to growing concerns about sustainable development, corporate social responsibility (CSR) has been a prominent approach in the construction sector. While architectural design firms (ADFs) play a crucial role in construction projects, there needs to be more research on the adoption of CSR in these businesses. This research seeks to uncover sustainable CSR initiatives performed by ADFs in Vietnam. Critical CSR activities were initially identified through a literature analysis and semi-structured interviews. The performance of sustainable CSR in the ADFs, including economic CSR, social CSR, and environmental CSR, was then investigated by a questionnaire survey. A method of fuzzy synthetic evaluation (FSE) was employed to evaluate sustainable CSR performance of Vietnamese ADFs based on 226 valid responses. The results show that economic CSR is the most important group, followed by social and environmental CSR. This paper is valuable since it identifies CSR activity in ADFs. The article also offers advice for construction managers who aim to improve their CSR performance by examining the effective CSR practices in the ADFs.

Keywords: architectural design firms (ADFs), construction sector, corporation social responsibility (CSR), factor analysis.

An Analysis of Passive Design Strategy for Diamond Lotus Riverside High-rise Apartment Project in Ho Chi Minh City

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Abstract. Sustainable development is the key goal that most of the current architectural trends, including green architecture, have been targeting. In order to achieve that goal, energy conservation in buildings is always the prioritized aspect to be considered carefully during the design process, especially in green buildings. Among many solutions for energy reduction, the passive design comes first and has been long-term effective during the building life cycle. Located in Ho Chi Minh City, Diamond Lotus Riverside is considered the first high-rise apartment of a Vietnamese investor that applied for both LEED and LOTUS green building certification at the gold level. The survey results show that this project has achieved LOTUS provisional certification and significant energy-saving indicators. This research focuses on the analysis of the passive design strategy that has been carried out in the Diamond Lotus Riverside project. From there, lessons can be drawn for designing energy-efficient high-rise apartment buildings in HCMC and Vietnam in general.

Keywords: Passive Design, High-rise Apartment, Green Building.

Characterizing Urban Development Patterns for Informed Climate Adaptation: The Case of Can Tho City, Vietnam

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Abstract. Urban adaptation a critical issue for Can Tho located in Vietnam's Mekong Delta, where despite significant scientific unknowns and uncertainties, strategic and robust policy decisions and action plans are urgently needed. This paper presents the classification of the city into different spatial units based on housing archetypes, functions, infrastructure, degree of planning, density, accessibility and open space. The official land-use plan for Can Tho until the year 2030 was used to accurately map 78,527 polygons into 53 distinct structures reflective of actual land-use and densities. The findings show that the current built-up land cover of the city is 6,677 ha (4,227 ha urban residential, 1,580 ha public use, and 868 ha industrial). Interestingly, informal temporary housing was seen to cover 128 ha, while currently another 503 ha of land is under construction. The analysis gives special emphasis to the understanding urban flood risks, and the socioeconomic fabric of the city in support of informing effective adaptation responses.

Keywords: urban structure types, Can Tho city , flood risk, adaptation, urban development.

Feasible Scenario for Expired Industrial Parks of Ho Chi Minh City

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Abstract. Viet Nam has oriented to carry out industrialization for the sake of socio-economic development since last 3 decades. Ho Chi Minh city started the strategy for industry development from 1990. The authorities implemented land use master plan to clarify industrial belt surrounding city's periphery; approved investment projects and issued permission for construction industrial parks. All were ready to relocate workshops, plants out of inner city. Tax exemption policy in the commence years of operation production work in good condition with adequate infrastructure facilities and separation from residential area have helped attracting manufacturers to industrial zones, thereby the city has fulfilled the goal of increasing income from Industry in GDP and other social goals as well. At the time of policy making to promote industrialization, the type of industrial park was defined with an operating term of 50 years. After 30 years implementing industrialization, HCMC government is considering feasible scenario for industrial parks after the 50-year term expired and where will the manufacturing activities be arranged to ensure their contribution to the GRDP.

Keywords: industrial park, industrialization, deindustrialization.

Abbreviations:

EPZ: Export Processing Zone

GRDP: Gross Regional Domestic Product

HCMC: Ho Chi Minh City

Hepza: HoChiMinh city Export processing and industrial Zone Authority

SHTP: SaiGon High Tech Park

IP: Industrial Park

VNU-HCM: VietNam National University – HoChiMinh City

Flexible Living Space Organization for High-rise Apartment in Ho Chi Minh City

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Abstract. The process of urbanization is taking place strongly, creating pressure on the environment, resources, and ecosystems. Global climate change has led to serious consequences for human life. In 1980, the term "sustainability" appeared as an important attribute required for development in all fields. In the field of architecture and construction, sustainable development has become the guideline for all activities of architecture in the 21st century, as mentioned in the Beijing Charter 1999 [9]. Integrating flexible adaptability in the built environment can contribute to sustainable development both socially, economically, and environmentally [7]. In Ho Chi Minh City (HCMC) in particular and large cities in general, the design of high-rise residential buildings still has many shortcomings, such as scalability and low ability to transform functional space. Flexible design for the organization of apartment space is essential to meet the fluctuations of interior space due to factors such as climate, culture, society, economy, and technology [12]. In this study, flexible organization and transformation solutions for living space in high-rise apartments in HCMC are proposed based on the inheritance of existing features combined with flexible housing design strategies. The results are meaningful for meeting the requirements of changing functions due to the diversity of current and future user needs.

Keywords: high-rise apartments, flexible architecture, adaptable architecture.

Gaps in Studies and Implementations on Thermal Comfort in Residential Buildings in Vietnam

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Abstract. Many researchers in the field of human comfort around the world have found that the adaptive model is likely an appropriate approach to define the comfortable condition for buildings in warm-humid regions. The climate in Vietnam is characterised by annual high temperatures and humidity. Therefore, achieving the statement of thermal satisfaction for humans in that environment is challenging, particularly in free-running buildings. The paper overall reports studies on the thermal environment and human comfort perception for buildings including residences in the warm tropics. Besides, experiences of research methods were also learnt from those previous works. Another part of the current paper looked through available studies on human comfort in Vietnam. Moreover, international and national standards of thermal comfort conditions applied in designing residences were also reviewed. The insights of such studies findings show potential similarities or differences in applications in Vietnam's context. Acquiring and understanding relevant knowledge and experience of human thermal conditions at both global and national levels is significant to find gaps in research and practice. As a result, there are 6 limitations found. They will help policymakers, planners, and practitioners assess rightly the current quality and quantity of comfort studies, find the necessity of future research developments, and have new actions to improve and build a better practice environment in Vietnam, especially in designing and constructing good dwellings, that provide comfort, health, and well-being for residents, high performance and energy efficiency for buildings, and less impact on nature.

Keywords: human thermal comfort; warm-humid climate, residential buildings, standards.

Indicator System to Quantify the Adaptability of Urban Spatial Structure to Drought and Flood Coexistence (DFC) in Ninh Thuan Province, Vietnam

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Abstract. Since Climate Change (CC) impacts on our cities, have enormously increased in the past decades. The viewpoints regarding cities have been changed from sustainability to resilience and adaptation. However, measuring adaptive urban areas concerning CC is still a big issue. Drought and flooding are costly extreme weathers caused by CC in the centre of Vietnam, especially in Ninh Thuan province. The regional and city-level findings show that urban spatial structure has changed over time and caused conflicts with drought and operational flood regimes. This research aims at establishing a quantitative and qualitative indicator system to measure adaptive urban spatial structures to drought and flood across scales in the province. The research includes four parts. The first part introduces the Ninh Thuan province and Phan rang-Tháp Chàm context, focusing on transforming urban spatial structures and drought and flood coexistence (DFC) status. The second one reviews the current literature on measuring systems of adaptive cities. The central part of the research is on the third. The study methodology and methods are first introduced, based on extracting remote-sensing images to geospatial maps, from which urban spatial transformations are examined. Furthermore, the transformations of urban spatial structures across scales are later explored to discover the major changes that have led to increased DFC intensity in the province. The results found in the investigation will be the critical quantitative and qualitative indicators to measure adaptive urban spatial structures changing over time in correlation with DFC in Ninh Thuan province. The final part concludes with a method of quantifying the adaptability of urban spatial structures across scales to DFC through an adaptive indicator system.

Keywords: adaptive indicators, adaptive urban spatial structure, remote sensing.

Integrating Disaster Risk Reduction in Urban Planning – Southern Urban Area of Ho Chi Minh City, Vietnam

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Abstract. The Southern Urban Area of Ho Chi Minh City is one of the fastest-growing urban areas in Vietnam, with a rapidly increasing population. On the other hand, this area faces risks of flooding due to low-lying terrain conditions and rising sea levels due to CCs (CC). Flood risks in Nha Be District are forecasted to cause significant damage to many residential areas and technical infrastructure systems and hinder urban development. For those reasons, urban planning can be considered as one of the practical solutions to reduce risks and damages from natural disasters in urban areas by integrating planning solutions, for example, integrated planning process, orientation and development of measures to reduce disaster risks. This study presents the following contents: (1) An Assessment of the inundation situation and risk of damage from flooding in Nha Be District; (2) Briefly describing of the planning system in Vietnam and the possibility of integrating disaster risk reduction (DRR) in urban planning; (3) Proposing integrated solutions reduce flood risk in urban planning in Nha Be District.

Keywords: disaster risk reduction (DRR); flooding; urban planning.

Interactions between Urbanization and Logistics Infrastructure in Suburbs of Ho Chi Minh City

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Abstract. The infrastructure of transport system shapes the urban spatial structure. Within that framework, there are nodes as pull - factors to economic activities that promote urbanization or urban upgrading. During the process of urbanization, those nodes have been different at their time and locations. In Ho Chi Minh City, from 1995 to 2015, it had been industrial park on the periphery of the city, that play the role of growth pole in motivating amazing rapid urbanization of the outskirt. Meanwhile, commercial centers in the inner city played a role in attracting socio-economic activities, creating a new urban appearance. The urban appearance reflects the city's main economy, which is industry and services. From 2016, e-commerce has grown strongly, especially in the period of 2020-2021, due to the impact of the global Covid-19 pandemic, new nodes appearing in the urban infrastructure framework are: commodity distribution centers. The change in the method of buying and selling goods contributes to promoting the development of logistics infrastructure, thereby, creating a new appearance of the city, reflecting the main economic activities are industry and logistics services. The issue that needs to be discussed is where to arrange distribution centers in order to effectively promote urbanization.

Keywords: e-commerce, logistic centre, urbanization.

Abbreviations:

EPZ: Export Processing Zone

GRDP: Gross Regional Domestic Product

HCMC: Ho Chi Minh City

IP: Industrial Park

Orienting Sustainable Planning in the Developing Coastal Tourism for Study Case - Quang Nam Province, Vietnam Vision to 2050

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Abstract. Coastal tourism was considered the oldest segment in tourism industry containning negative impacts to environment. The tourism industry in coastal Quang Nam province belong to the middle of Vietnam is not exception. The huge number of tourists, plus the lack of stricted environmental management had extremely negative impacts on the integrity of the natural environment as well as social life in that. Furthermore, buiding traditional tourism infrastructures have affected other buffer zones of coastal tourism facilities which suffer the natural disasters and climate change increasion. Therefore, sustainable planning model is considered the optimal and potential solution for coastal tourism development in Quang Nam province, Vietnam, in order to adapt to the decreased criterias of global climate change.

Keywords: coastal tourism, sustainable coastal tourist model, diffused planning, global climate change, tourist infrastructure.

Proposing Solutions for Rural Housing Architecture to Adapt to Climate Change of Tien Giang Province in Vietnam

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Abstract. Tien Giang is a typical province of the Mekong Delta with both interlaced rivers and a long coastline, which is not outside the scenario of global climate change. According to the climate change scenario for Vietnam in 2016 updated to 2020, Tien Giang is one of the three provinces at high risk of flooding in the Mekong Delta. In 2021, the weather, hydrology, and landslides in major canals and inland areas will be extremely complicated in most of Tien Giang province due to the influence of climate change, especially in rural areas. It was the rural houses that suffered the heaviest damage. On the other hand, rural urbanization has negatively influenced the overall image of the rural social structure, of which the culture, customs, habits, and living conditions of the people and, especially, the morphology housing architecture of the area are all being affected. In this study, the current architectural status of rural houses in Tien Giang is systematically evaluated, and the impacts of climate change are clarified on each type of house. On the basis of the relationship between indigenous architectural features and the economic, social, and environmental conditions of Tien Giang province, architectural solutions to cope with climate change are proposed to improve the quality of life, living, minimizing negative impacts on the environment and meeting the needs of sustainable development.

Keywords: rural housing, climate change, sustainable development.

Research on Co-Housing Model – Experience and Applicability to Housing Design for Low-Income People in Ho Chi Minh City, Vietnam

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Abstract. The co-housing model encourages social interaction, communication, support and help among residents. Major cities and towns around the world have been moving towards this model to meet the huge housing needs of urban dwellers, while also adapting to today's environmental and social challenges, including Ho Chi Minh City, Vietnam. A huge difficulty of HCMC in recent years is meeting the housing needs of more than 13 million residents, more than half of whom are middle- and low-income people. Most of them want to find employment and education opportunities in big cities, and they share the same difficult living condition in an expensive city like HCMC. Therefore, finding a safe and affordable housing to live is the first important thing for workers and their families. This article is a qualitative study using mixed methods including document synthesis & comparison, mapping and observation methods. Based on understanding the cooperative housing model and practical experience both inside and outside the country, the authors outline the co-housing model and propose a set of criteria for establishing a cooperative housing model for low-income people in HCMC. From there, assessing the suitability between the set of criteria and the applicability of different types of housing for low-income people in HCMC. This study aims to propose a table of criteria for evaluating the application of the co-housing model in housing design for low-income people in Ho Chi Minh City.

Keywords: co-housing, evaluation criteria, housing for low-income people, Ho Chi Minh.

Smart Village – A Chance Potentials to Apply in Vietnamese Rural

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Abstract. 65.4% of Vietnam's population belongs to its rural areas. The migrant worker from rural areas accounted for 20% (Ho Chi Minh City), up to 40% (Binh Duong) of the total urban population. The number of migrant workers from rural areas significantly impacts Vietnamese urban and rural urbanization. In response to sustainable development, many rural areas need an intelligent solution that applies science and technology to increase education, health, salary security, manufacturing enterprises, clean water, proper sanitation, and environmental sustainability. The article aims to introduce (i) the smart village concept, (ii) some case studies of the smart village in the world, (iii) Vietnamese villages, and iv) smart village proposal to Vietnamese rural.

Keywords: sustainable development, smart village.

Sustainable Architectural Characteristics of Housing in Vietnamese Mekong Delta

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Abstract. The study aims to investigate sustainable architectural characteristics of housing in Vietnamese Mekong River Delta. To achieve the objective, the following approaches were implemented. Firstly, the concepts of sustainable architecture, which the styles and construction principals adapting to surrounding environment, are briefly described. Secondly, Khmer and Cham ethnic group are known as the second and third largest ethnic groups living in Vietnamese Mekong River Delta. Their housing is located in the rural areas, where is affected by disadvantage of natural environment. Khmer and Cham ethnic group's housing contains the characteristics adapting to surrounding environment. Hence, a survey of Khmer and Cham ethnic group's housing in Vietnamese Mekong Delta is conducted to examine characteristics of settlement, planning scheme, form, façade and housing materials. Twenty of Khmer housing and fifteen of Cham housing are comprehensively surveyed in this study. Lastly, these characteristics are analyzed and compared to the concepts of sustainable architecture to determine whether the sustainable architectural perception have existed in Khmer and Cham ethnic housing. The result reveals that the Khmer and Cham housing contains the characteristics which are designed in harmony with surrounding the environment. These characteristics should be the valuable lessons to apply to current housing design in Vietnamese Mekong River Delta.

Keywords: sustainable architecture, Khmer ethnic housing, Cham ethnic housing, Vietnamese Mekong River Delta.

Teaching Structural Design to Architecture Students: A Case Study on Footbridge Design Exercise for Undergraduate Students

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Abstract. This paper represents an action research-based inductive teaching approach to structural design to architecture students through a given task of freestyle footbridge design. The objective is to educate undergraduate architecture students about the basic understanding of structural systems and their integration into design through the appropriate choices of materials based on their structural and architectural qualities. The main aim was to convey the importance of a collaborative design approach from the early design stage and during the design progress. For this reason, an architect needs to have a basic understanding and logic of structures. This paper highlights the different classifications of structural systems so that students can have a basic idea of structural typologies that can fit with their design vision. Students were given two routes to design the footbridge. One is the 'form-making' approach, through which they can come up with the bridge design form based on the context and design concept and then select an appropriate structural system to develop the final design. This is a linear process. Another is the 'form-finding' approach, through which students will first set the structural conditions and restrictions and then find suitable force-based forms either by physical model testing or digital tools. Here, some sample footbridge designs of 'form-making' and 'form-finding' are represented.

Keywords: architectural education, structure, digital design, physical model, active learning.

The Role of High-Rise Buildings in Sustainable Development in the Tourist City of Nha Trang from the Perspective of Urban Landscape

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Abstract. The article studies the role of high-rise buildings in sustainable development in the tourist city of Nha Trang - Vietnam from the perspective of urban landscape. Research to determine the influence of high-rise buildings on urban structure and landscape. High-rise buildings, besides bringing positive values and changing the urban landscape, always have an impact on social life. High-rise buildings play an important role in defining sustainable and livable cities. The research method is carried out through the collection of spatial development and tourism data of the city, along with architectural design documents of high-rise buildings. Assess the development stages of high-rise buildings by analyzing the correlation characteristics between high-rise buildings and urban landscapes. As the demand for tourism development increases, the rapid urbanization process, and the high-rise buildings have had impacts on the environment, urban landscape, and local communities. The study points out the need for legal reform to organize and manage high-rise buildings suitably for tourism development, in order to avoid negative impacts on the visual environment caused by them. The research's results serve as the basis for proposing solutions to organize, manage, and exploit coastal urban space in order to develop a sustainable tourist city.

Keywords: high-rise buildings, sustainable development, urban landscape, Nha Trang.

Utilizing Deep Learning to Track Urban Density Parameters in Zoning Practice-Based Areas

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Abstract. In response to the challenges posed by rapidly growing cities, there is a pressing need for innovative solutions in urban evaluation and orientation. Building density and building coverage ratio (BCR) are critical factors in this regard. Although several methods have been proposed for calculating BCR, there remains a need for a swift and effective technique to assist city administrators and planners in tracking density parameters. This study summarizes the challenges and future research directions in using a DL-based approach to measure BCR. To support the practical application of this tool, the main stages of the end-to-end process are highlighted, offering insights for further improvement.

Keywords: urban density, deep learning, urban analysis, building coverage ratio.

Construction Management Session

A Conceptual Structured Model for BIM Application Acceleration: The Roles of The Industry

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Abstract: Building information modeling (BIM) application trends in the architecture, engineering, and construction (AEC) industry have indicated benefits to projects. The Vietnamese government has published many policies and legislative documents promoting the implementation of BIM by construction organizations. However, adopting BIM in projects has a barrier due to the lack of positive BIM-practicing attitudes and behaviors in construction organizations. Furthermore, authorities have difficulty identifying issues for which construction organizations demand assistance. The content analysis technique was adopted to collect and analyze data from previous studies, then semi-structured interviews was desinged to record expert opinions. This study proposes a conceptual model for BIM application acceleration directed to the roles of the management and the industry. The model consists of seven aspects the industry should manage: education, sharing, benchmarking, self-assessment, BIM awareness, BIM benefit, and a BIM acceleration platform. The results are hopefully useful for the industry's management to motivate the BIM application in construction.

Keywords: Building Information Modeling (BIM); Education; Benchmarking; Self-Assessment; Sharing.

A Deep Learning-Based Image Captioning for Automated Description of Structural Components Condition

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Abstract. Along with visual data, textual information on civil engineering projects can provide a rich source of expert experiences and technical knowledge for diagnosing structural damage causes and its countermeasures. By implementing a cutting-edge deep learning approach in SHM, the visual assessment with the interrelation of structural components and their working condition can be retrieved for providing an efficient damage evaluation, and professional descriptions documentation to be generated. The study proposed a methodology of image captioning architecture of convolution neural networks (CNNs) and recurrent neural networks (RNNs) for generating condition assessments of structural components. The purpose of this study is to investigate the pragmatic implementation of image captioning technology in structural health monitoring scenarios, improving the quality of inspection and addressing the labor shortage of conventional maintenance. The results indicate that the proposed method can provide automated coherent text descriptions of structural components and their working conditions, simplify the inspection process, and deliver efficient maintenance management.

Keywords: Structural health monitoring, deep learning, image captioning, condition assessment.

Energy and Resource Optimization in Building Smart City Using Hybrid-Multiver Optimizer (hMOV) Algorithm

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Abstract. The increasing demand for clean and efficient energy for construction industry, especially for developing and managing smart cities has led to the development of microgrids. Common problems with these strategies are the demand and supply of the energy constantly conflicted, as a result, the energy usage frequently inefficient. To solve this problem, optimization techniques and heuristics methods are utilized. Mathematical optimization procedures can obtain optimal solutions, but they are only suitable for small-scale problems. For large-scale situation, artificial intelligence techniques have been applied. In this paper, a Hybrid version of the multi-verse optimizer (MVO) and the Sine Cosine Algorithm (SCA) is introduced in order to improve the exploration and exploitation balance of the standard MVO algorithm. Secondly, by adding cost-effective objective function to the proposed method, the cost reduction and execution time of the algorithm will as well improve compare to other he cost reduction and execution time improvement. The proposed hybrid algorithms also find improved optimal solutions for energy optimization by illustrating its searching ability with dirverse search space problems. As a result, the proposed algorithm will demonstrate its avaiability to solve real unknown search space construction and non-construction problems.

Keywords: energy management, hybrid multi-verse optimizer (MVO), artificial intelligent, smart city.

A Modified Sine Cosine Algorithm for Time-Cost Trade-Off Problem

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Abstract. The relationship between time and cost in a project is known as a trade-off, and it means that the project completion time will be longer if fewer resources are used. In recent years, time–cost trade-off problems (TCTP) have been extensively studied for optimizing the scheduling and management of construction projects. One of the promising random optimization algorithms in this field is the sine cosine algorithm (SCA), which provides a simple evolutionary algorithm with the ability to effectively exploit the search space. However, its ability to explore the search area is still limited, leading to fast convergence and local optimization. This study introduces a new modified sine cosine algorithm (mSCA), which is a combination of the roulette wheel mechanism and SCA, aimed at improving its ability to explore the search area. The performance of mSCA was evaluated through the use of three small-scale test problems of the time cost optimization, consisting of 18 activities. The results indicate the effectiveness of mSCA in solving small-scale TCTPs when compared to state-of-the-art techniques.

Keywords: roulette wheel mechanism, sine cosine algorithm, time–cost trade-off, project management.

An Investigation into Augmented Reality's Ability to Assist the Preconstruction Phase of Building Projects

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Abstract. This study explored the ways in which augmented reality is capable of assisting Architectural, Engineering and Construction (AEC) professionals in the pre-construction process of building projects. The available literature acknowledged that there was scope for more in-depth research into the opinions of AEC professionals on digital technologies, particularly their views on AR. For this reason, through the use of semi-structured interviews, researchers gained a better understanding of the current applications of AR available to professionals, the different uses of AR for the pre-construction phase, and future recommendations for AR. There were three main findings. The first was that there had been a number of AR applications that could be specifically applied to the industry. Secondly, AEC professionals revealed that there were a number of reasons why they were implementing AR in their work, inclusive of assistance to defect analysis, the design stage, and enhanced communication. Finally, AEC professionals offered a number of future recommendations but argued that AR uptake would not happen until there was a cultural transformation among professionals. The majority of the findings supported the literature on the use of AR in the AEC industry. The data produced from the interviews could be of use to a number of different professionals within the AEC industry. It would be of particular use to AEC companies who are considering investing on AR.

Keywords: augmented reality, pre-construction, construction management, digital transformation.

An Investigation of the Effect of BIM Implementation on Improving the Relationship between Architects and Quantity Surveyors

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Abstract. Quantity surveyors and architects both play an important role within the construction industry and are heavily involved with one another throughout their works within a project. However, at times, certain issues relating to costs, designs and other factors can lead to their relationship becoming strained. There are limited studies that have looked into the relationship between quantity surveyors and architects or provided any solution on how to improve their relationship. This study investigates the implementation of BIM as a means to improve the relationship between architects and quantity surveyors. The findings from the qualitative research were then analysed through thematic analysis and compared with secondary data from previous literature to validate the findings. The analysis led to four themes: 'Dependence on the person', 'Misunderstandings', 'BIM efficiency' and 'Requirements of BIM' along with one subtheme: 'Universal working' being generated. The analysis of the results concluded that BIM could be implemented as a means to improve the relationship between architects and quantity surveyors. This was due to the nature of BIM and how it could promote collaboration and communication for both quantity surveyors and architects as they are both working within elements surroundings designs and costs. Although, key procedures were identified that would need to be satisfied in order for BIM to successfully improve the relationship, it was overall found that BIM possess the qualities to improve the relationship between the two professionals.

Keywords: building information modelling, quantity surveyor, construction management, relationship, architects.

An Optimization Model for Building Envelope with Energy Efficiency Objectives in Building using the NSGA-II Algorithm

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Abstract. The energy consumption level in buildings is a critical factor related to the design and operation of a project. The selection of architectural design options and building envelope materials from the early stages through Building Information Modeling (BIM) has become a research trend in order to reduce energy consumption in buildings. In this paper, the authors develop a NSGA-II (Non-dominated Sorting Genetic Algorithm II) optimization model combined with energy prediction using the Random Forest machine learning algorithm, trained on energy simulation models (BIM-Design Builder) to optimize design factors such as window types, window-to-wall ratios, roof materials, and wall thicknesses/types. The goal is to address surface design issues during the design process and achieve the highest energy efficiency in the building.

Keywords: building energy efficiency, architectural design options, building information modeling – design builder (BIM-design builder), optimization model, NSGA-II (non-dominated sorting genetic algorithm II).

Analysis of Influencing Factors by Machine Learning to Predict Energy Consumption of Educational Institutes

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Abstract. Educational institutes, as innovation drivers of science and technology worldwide, are in a great position to advance energy efficiency. However, progress on building energy efficiency studies have generally been limited by: 1) scarcity of data on building energy consumption, and 2) highly complex/technical traditional building energy estimation methods. The advent of new and dynamic streams of building energy data and machine learning methods provide new ways to model building energy consumption. In this report, the team is tasked by California City Hall to explore the energy efficiency of universities in the California area. This is part of their urban strategy to reduce building carbon emission and to promote education on climate change mitigation and adaptation. Particularly, they have become aware of a new, extensive building meter dataset (Building Data Genome 2 Project) and would like to understand how data science and machine learning methods can be used to predict and model energy consumption of educational institutes. In this paper, we start by outlining key movements in climate and sustainability that sets the context for our study. Next, we proceed to examine existing research on factors affecting building energy consumption and conduct an exploratory analysis of our dataset to identify buildings with energy consumption above the benchmark. We then proceed to employ, evalutate, and compare the effectiveness of various machine learning algorithms (XGBoost, RandomForest, LightGBM) for building energy estimation before concluding with recommendations to reduce building energy consumption.

Keywords: machine learning, energy consumption, educational institute, exploratory analysis, recommendation, advanced energy efficiency

Analysis of the Aspects Influencing the Selection of Formwork in High-Rise Buildings Construction in Vietnam

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Abstract. The proper formwork system is one of the most important factors in the success of high-rise building construction projects. However, this work is complicated when it is necessary to consider many aspects of impact to make the right decision for each project. Through conducting a survey with respondents who are individuals and experts in the field of construction, the research aims to determine the factors influencing the decision to choose formwork in the construction of high-rise buildings. After analyzing data collected from 190 valid responses with SPSS software, the research has identified 6 main groups based on 33 factors given in the survey. The research results have determined the greatest influential factors on formwork choice. From that, the results of this study shall assist managers in expanding their understanding of formwork systems, supporting planning and decision-making more successfully, and contributing to the success of today's high-rise building construction projects.

Keywords: formwork, high-rise buildings, construction projects, factor analysis.

Analyze the Factors Affecting the Generation of Construction Waste and Propose Solutions

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Abstract. Waste from construction activities is seen as an increasingly focused issue as urbanization generates large amounts of construction waste. Construction waste negatively impacts the construction industry in particular and the country's economy in general. A comprehensive understanding of the factors that generate construction waste will enable effective construction waste management and reduction. From evaluating previous studies and consulting experts, the study identified 36 factors affecting the generation of construction waste at construction sites in Vietnam. From evaluating previous studies and consulting experts, the study identified 36 factors affecting the generation of construction waste at construction sites in Vietnam. A survey was conducted with individuals and professionals working in the construction sector. After conducting statistics and quantitative analysis, the study found 6 main groups of factors, of which the lack of construction waste management and treatment plans is considered the most contributing factor to the amount of waste at construction sites. In addition, the study has also proposed a number of solutions to limit construction waste generation.

Keywords: construction waste, waste management, causes of waste; construction site.

Analyzing Digital Transformation Barriers in Small and Medium-Sized Construction Enterprises in Ho Chi Minh City

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Abstract. The COVID-19 epidemic that has taken place since the beginning of 2020 has caused businesses in Vietnam to be severely affected. In that context, the need for digital transformation becomes urgent when businesses are forced to innovate their models, gradually shift business activities on digital platforms, seek more markets, cut costs, and upgrade their businesses with high operational efficiency and competitiveness to adapt to the new context. Although the needs of businesses for digital transformation are significant, there are still many barriers that not only international but also initial small and medium-sized companies face when applying digital technology. Research aimed at elucidating the significance and inevitability of digital transformation in the domestic construction sector, as well as identifying and assessing digital transformation hurdles in small and medium-sized construction companies in the Vietnam. Construct a model to evaluate the influence of digital transformation hurdles on the degree of digital transformation among small and medium-sized construction companies in Ho Chi Minh City. The findings of the research indicate that the elements that were surveyed have an effect on the degree of digital transformation that is taking place in small and medium construction businesses in Ho Chi Minh City. The research also includes recommendations for potential solutions that might assist small and medium construction businesses in Ho Chi Minh City in overcoming obstacles that stand in the way of their participation in the ongoing digital revolution.

Keywords: digital transformation (DT), small and medium enterprises (SME), barriers, cloud computing.

Analyzing Problems Affecting the Operation of the Construction Enterprise due to Covid-19 Pandemic – Case Studies in Vietnam

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Abstract. From a social to an economic perspective, COVID-19 has had a significant impact on the entire world, affecting almost all fields. After a successful first year of fighting the pandemic, Vietnam entered a difficult period when the epidemic spread rapidly from the end of May 5, 2021. Construction companies were among those most severely impacted by the shutdown, which interrupted business operations. Most construction companies find challenging to operate when faced with important problems such as the volatility of the supply chain stagnation, the expense of renting equipment and buying materials, and several construction projects being delayed due to the impact of the virus on workers. The purpose of the research is to figure out the impacts that the COVID-19 pandemic has on construction companies in Vietnam. Researchers performed a survey of individuals and experts in the construction industry and using the Exploratory Factor Analysis (EFA) methodology, the results of this study identified 6 major categories of 37 impacts of the pandemic on construction companies. In addition, this study ranked the impacts based on the level of assessment of the surveyed people. The findings demonstrated that the greatest negative impact on the construction industry is the labor shortage.

Keywords: COVID-19; construction company; impact; pandemic; Coronavirus.

Apply Smart Blockchain Framework in the Construction Contract Management

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Abstract. Construction projects, with their complex nature, large scale and various uncertainty, usually involve many parties with complicated collaboration. Conventional centralized governance fashions where client and/or general contractor play the key roles and have overpowering force over others have been proven not effective in settling current loopholes. Blockchain, a distributed ledger technology with high transparency, immutability and security, is believed the solution as it has been applied successfully in many other industries with similar aims. This paper seeks to present a comprehensive empirical Blockchain-based contract management framework applicable in construction sector to reduce the risk of payment, cash flow and conflict resolution failure and strengthen overall project management procedure. The research outcomes were reviewed by a committee in which members are either experts in construction sector or Blockchain field via a written structured interview questionnaire. The evaluation result has demonstrated the superior of proposed framework for sorting out the automatic interim payment with presence of a general contractor and one nominated subcontractor as well as solving the delay responsibility between a client and a general contractor and implementation of subsequent contractual events.

Keywords: blockchain, smart framework, construction management, smart contract.

Applying Artificial Intelligence to Solving Multiple Optimization in Construction Management: Hybrid Slime Mold Algorithm with Opposition-Based Learning

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Abstract. This study analyzes the hybrid algorithm between Slime Mold Algorithm (SMA) and Opposition-based learning (OBL), in which Adaptive Opposition Slime Mold Algorithm (AOSMA) is proposed to simultaneously solve the triple-objective optimization problem in construction projects. The combination of OASMA aims to improve and upgrade the model in order that the exploration, exploitation and acceleration of the convergence are perfected and local optimizations are avoided during rapid convergence, accordingly, the best pareto solutions shall be provided to the project. The Time-Cost-Quality trade-off problem is one of the prerequisites which lay a solid foundation for the success of a construction project, one of the challenges in simultaneous optimization of the factors to obtain consistence with each specific activity of the project. In order to enhance the superiority and efficiency, the proposed model is compared with previous algorithms (MOSGO, MODE, MOPSO and NSGA-II) for the comprehensive development of the proposed model. According to the overall results, the AOSMA model shows diversification and provides a strong and convincing optimal solution for readers to recognize the potentialities of the proposed model.

Keywords: time-cost-quality trade-off, adaptive opposition slime mold algorithm, optimization.

Applying Blockchain Technology in Smart Contracts for Construction Payment: A Proposed Solution

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Abstract. The construction industry has been facing the challenging problem of delayed payments and disputes over payment between owners and contractors. While multiple studies have been conducted to address this issue and reduce the delays caused by slow payments, the results have not been optimal. In this study, we propose a new process that leverages Smart Contract technology in Blockchain to solve the problem of slow payment in construction projects and post-contract disputes. This process aims to minimize the risks associated with project stoppage or prolonged duration, ensuring project continuity and safeguarding the rights of all parties involved. Specifically, we utilize Smart Contracts to facilitate automated payment transactions between owners and contractors. The Smart Contracts also act as a third-party monitor to ensure that both parties fulfill their obligations in the project. Furthermore, Blockchain technology is employed to record all project lifecycle transactions in a chronological order, enabling efficient management and retrieval of project-related data. Overall, our proposed approach offers a novel solution to the challenges posed by delayed payments and disputes in the construction industry, enhancing transparency, and promoting trust among project stakeholders.

Keywords: blockchain; smart contracts; project management, construction payment.

Assessing Human Resource and Organizational Factors Influencing the Adoption of Building Information Modeling in the Vietnamese Construction Industry

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Abstract. In the context of Building Revolution 4.0, the application of new technologies is an inevitable trend and competitive advantage. Building Information Modeling (BIM) - a technology platform for building planning, design, construction, and operation - facilitates the project life cycle by enabling the sharing of data and relevant information among stakeholders. The adoption of BIM in Vietnam is growing in popularity and is likely to become the industry standard for future construction project planning. The implementation of BIM relies heavily on people and organizations. Based on previous research, this study assesses 10 human resource and organizational factors that influence the adoption of BIM in the Vietnamese construction industry. The study was quantitatively analyzed using SPSS software and an online questionnaire survey to assess stakeholders' perceptions of each identified factor. In addition, a 10-factor ranking analysis was conducted based on the Relative Importance Index (RII) for the adoption of BIM in Vietnam. The article also discusses stakeholder perceptions to enable informed decision making in developing a BIM implementation strategy. Practical and insightful recommendations are provided for companies and key stakeholders to improve the implementation of BIM in construction projects.

Keywords: adoption, building information modeling, human resource, organization, relative importance index.

Assessing the Potential Application Of BIM and High Technology Integration in Building Facility Management

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Abstract. Building Information Modeling (BIM) has grown in popularity in the construction industry over the last decade, particularly off-site, where circumstances are digitally realized and simulated. However, the use of high-tech integrated BIM in the management of building operations is still restricted. Augmented reality (AR) is a technology that can bridge the gap between the digital and physical worlds. Many previous studies on the application of AR and BIM have been carried out to facilitate enhanced interaction in the field, but there has not been a specific study on BIM-based AR system process for specific to existing building operations as well as BIM model optimization throughout the project life cycle. This study aims to evaluate the potential of AR and demonstrate how to effectively deploy a BIM-based AR system for operations management using a component-based software engineering approach. The findings of the research indicate that augmented reality may considerably bridge the semantic gap between the digital model and the actual world and that the necessary components exist to develop a BIM-based AR system for building operation management. Integration between AR and BIM has the potential not only to solve information processing problems but also to examine extra needs for future models and tools.

Keywords: building information modeling, facility management, QR code, augmented reality.

Automatic Extracting Road Edges from Mobile Laser Sanner Point Cloud

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Abstract: Information on road networks is essential in road planning and quality management. Many studies have tried to extract road surfaces, edges, and furniture from point clouds based on the advantage of rapidly collecting data from laser scanners. However, existing works have gaps in removing the road surface information for engineering purposes. This study proposed an automatic method to extract the road edge points and the road surface from mobile laser scanning (MLS). The method started to extract ground points using cell-based region growing and cell-based plane filtering. Then, contextual knowledge and Delaunay analysis were implemented to obtain the road edge points. Finally, the combination of point-based region growing, contextual knowledge, and RANSAC-based outlier removal was used to group the road edge points and remove incorrect results before generating the edge. The proposed method was tested on an MLS data set acquired from the road around Delft University of Technology, The Netherlands. Results showed that the method could extract the road edge with 95.9% in terms of the length, while the error of the road width is around 3m when compared to the ground manually extracted from the MLS data.

Keywords: road extraction, mobile laser scanning, cell-based-region growing, cell-based plane filtering, RANSAC-based outlier removal.

Creating a Digital Elevation Model from Photos Captured by a Low-Cost Uav- Based System

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Abstract. Currently, unmanned aerial vehicles (UAV) are commonly used to capture photos of the terrain as a quick and cost-effective data collection method. In this study, the authors proposed a method for creating the digital elevation model (DEM) from a point cloud generated from images taken by the UAV using the Structure from Motion (SfM) technique. Most commercial software for UAV image processing results in DEM modeling in the form of rasters, so its application is narrowed and inaccuracy. In this study, the authors created a point cloud using open-source Colmap software and Agisoft Metashape commercial software and calibrated it using CloudComapre software. Next, ground points are filtered in 3 main steps. The data is organized in grid cells. Non-ground cells are removed using kernel density estimation (KDE) and histogram analysis. Ground points from non-ground cells are extracted together with ground cell points using region growing. Finally, the digital elevation model is created.

Keywords: UAV photogrammetry, unmanned aerial vehicles, digital elevation models, structure from motion.

BIM-Based Framework for Creating Automated Construction Schedules: A Proposed Solution in Vietnam

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Abstract. In recent years, Building Information Modeling (BIM) has garnered a great deal of interest due to its benefits in design, generating construction schedules, and monitoring of the building process. In Vietnam, the creation of a construction plan depends on the knowledge and experience of designers, and they typically create these schedules manually. This study proposes a framework for developing a tool with features that suggest construction schedules based on created 3D-BIM models to achieve a fully automated and efficient design process. The framework integrates digital graphic information of building information modeling (BIM) with construction and schedule data, producing construction activity sequences pertinent to each other and the proposed building design. The visible geometric representation and engineering data are merged into a single database that project managers can use to examine and modify the schedule effectively. As a result, resource-intensive activities can be reduced and productivity can be increased.

Keywords: building information modeling, construction schedule, automation generation, optimization algorithms, IFC standard classifications.

Cement Transport Vehicle Routing Problem with Hybrid Sine Cosine Optimization Algorithm in Construction Management

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Abstract. This study proposes an optimal cement transport vehicle routing plan by using the Sine Cosine Algorithm (SCA) was used in combination with different learning methods of opposition-based learning and mutation and crossover. This combined algorithm is called the hybrid SCA (HSCA). Developing a reasonable routing travel plan for commercial vehicles, for vehicles is made based on the needs of each store, the vehicle capacity, and the distance to each store must be considered. In order to prove the advantages of the developed SCA-OBL-MC (HSCA) algorithm, the performance of this algorithm was compared and evaluated against that of a paper that uses a specific model of 01 different case study and compares them with other algorithms. Thus, the findings of this research indicate that construction managers can utilize the hybrid sine cosine algorithm to create the most suitable routing plans for vehicles.

Keywords: Vehicle Routing Problem (VRP); Hybrid Sine Cosine Algorithm (HSCA); Construction Management.

Combining Building Information Modeling (BIM) and Choosing by Advantages (CBA) to Select Sustainable Design-Construction Solutions for Building Envelope

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Abstract. Nowadays, the construction industry is facing the fact that resources are becoming scarcer and the cost of raw materials and energy is increasing. At the same time, global warming is also a difficult problem for scientists as construction projects emit too much CO_2 during their lifecycle. The urgent task for designers now is to find alternative materials and design solutions that optimize energy consumption, save resources, and reduce CO_2 emissions. To accomplish this task, Building Information Modeling (BIM) and software in this ecosystem are not only used for modeling (3D), time simulation (4D), quantity measurement (5D) but also for energy consumption simulation. This study focuses on using BIM to simulate energy consumption for various types of building envelope materials, combined with the Choosing by Advantages (CBA) method, a multi-criteria decision-making method that has been widely applied in selecting design options, materials, and contractors related to sustainable construction. The result of this research is a simple and typical example of combining BIM and CBA to select sustainable design-construction options for the building envelope system and can be developed to apply to solve more complex problems related to sustainable design-construction in the future.

Keywords: building information modeling (BIM), choosing by advantages (CBA), sustainability, energy simulation, building envelop.

Composite System for Structural Enhancement and Efficient Heritage Conservation: A Case Study

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Abstract. Conservation of heritage buildings is an integral part of urban development in all the nations. Repair, restoration, retrofitting or upgrading works to such built infrastructure is quite challenging and essentially requires preservation of its architectural features. Such operations create complex decision making and execution challenges to the engineers. The present case study discusses one such project aimed at restoring and upgrading the heritage building constructed in 1950s in Singapore. The paper discusses various challenges faced and strategies adopted to restore the building within the regulations framed by Urban Redevelopment Authority, Singapore. The structure has suffered from the disadvantages of low-grade concrete, corrosive reinforcement, spalling and cross-sectional loss of steel. An ingenious engineering technique using composite system, combining the advantages of fibre reinforced polymer composites, corrosion inhibitors and conventional strengthening method was adopted to enhance the structural performance of the building to suit the increased loading conditions. It was observed that the proposed restoration practice ensured the safety and structural capacity without compromising the heritage values and architectural appearance of the building. The challenges experienced, lessons drawn and upgradation frameworks adopted in this study are expected to aid the researchers and practitioners in understanding and exploring various methods of heritage infrastructure conservation.

Keywords: heritage, conservation, fibre reinforced polymer, composites, corrosion.

Controlling and Managing Safety on the Construction Site by Using Artificial Intelligence Model

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Abstract. Ensuring occupational safety in the construction industry is of paramount importance. Personal protective equipment (PPE) is a critical component of safety measures on construction sites. However, manually monitoring workers' PPE and identifying violations of safety rules can be time-consuming and challenging. With the advent of artificial intelligence (AI), there is potential for real-time detection of PPE status and site violations, making safety management more efficient. In this technical article, the authors propose a model using YOLOv5 and other algorithms to detect workers' PPE and identify safety violations in real time. In the case study, the model demonstrates high accuracy and effectiveness compared to other popular object detection algorithms, making it a promising tool for safety management in construction sites. This study contributes to both knowledge and practice in the field of construction safety and highlights the potential of AI for automating safety management tasks. Possible reusable methodology allows future research in this area further improve the accuracy and efficiency of AI models for safety management, reducing the risk of accidents and injuries on construction sites.

Keywords: construction industry; occupational safety; artificial intelligence; YOLO; management.

Developing a Risk Assessment Process in Underground Construction

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Abstract. The construction industry is complicated because each project is unique. As a result of containing many uncertain factors, underground construction items are highly specialized. In Vietnam, only some contractors are qualified to participate in underground construction packages. Contractors are hesitant to join these packages because they have limited abilities in managing risks during the construction period. Currently, there is a lack of detailed procedures to serve contractors specializing in these packages. Some organizations adopted risk management processes in underground construction packages. However, risk factors in the whole construction phase have a big difference in the underground construction phase. This paper identifies a list of common risks in the underground construction phase to contractors by conducting literature reviews and a questionnaire survey. The paper proposes a process of risk assessment in the bidding phase of the underground construction package. Currently, most risk assessment efforts at this stage are fragmented, local and completely dependent on project managers. Based on the Plan-Do-Check-Act theory, the proposed process is developed to utilize the power of an organization when many individuals are involved. The proposed process is then evaluated in terms of both content and execution. Finally, an actual package is used to evaluate the proposed procedure's applicability.

Keywords: risk, risk factor, risk assessment process, underground construction, contractor

Developing a Toolkit for Assessing Labor Productivity on Construction Sites

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Abstract. Together with cost and schedule, labor productivity is an aspect of concern in construction. These aspects are closely related with each other. In the Vietnamese construction industry, labor productivity is low when compared to other countries. Most construction activities are directly undertaken on site. Therefore, construction organizations are facing various challenges in managing on-site productivity. Currently, there is a lack of tools to manage productivity on construction sites. This paper aims to develop a toolkit to support labor productivity management at construction sites. Specifically, the toolkit includes a system of representative elements that could help to assess the labor productivity management level of project construction components according to the built-in scale. The toolkit was developed based on the productivity management factors of the American Society of Civil Engineers (ASCE) organization and then evaluated using the 5-levels rubrics scale. The labor assessment model includes main components that are decomposed into representative groups of factors. In each representative group, there are also criteria for evaluating sub-measures labor productivity. Finally, the proposed tool is evaluated by experts.

Keywords: toolkit, factors, labor productivity, labor productivity management, construction sites.

Developing RTI-IMS Software to Identify Road Surface Damages

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Abstract. Nowadays, applying information technology to management is considered as one of the most important innovative methods, which will improve production and management efficiency in almost all aspects of life. Because of the outstanding advantages of information technology, it has been got great attention from scientific researchers all over the world. In this research, a software with advanced new technologies is built to manage the operation and maintenance of road – traffic infrastructure network automatically and efficiently. The software mentioned above, called Road Traffic Infrastructure Intelligent Management System (RTI-IMS), was developed based on the application of machine learning technology combined with GPS navigation to be able to automatically detect and mark damaged locations or signs of downfall of roads which are in the operation stage. RTI-IMS applies Yolo V5, which is one of the best advanced technologies in infrastructure images recognition, to identify road surface damage. In addition, the software is also combined with a real-time database GPS navigation to accurately provide the information of road damages to infrastructure authorities. The result of this research is the successful development of RTI-IMS software, which has been applied to support the detection of damages along some currently operating routes. The study provides local traffic management agencies with a tool for automatically detecting and publishing images on damages along certain road sections in the transportation network in three provinces and cities of Vietnam: Quang Ngai, Dong Nai, and Ho Chi Minh City. The published images mentioned above has been compared with the corresponding values obtained through the experimental measurement method of the local traffic management agency, achieving relatively accurate results.

Keywords: road damage detection; road maintenance; Yolo vV5; intelligent management system, construction management.

Energy Saving Solutions and Energy Consumption Prediction Model based on RF Algorithm (Random Forest) combined with BIM Simulation (Design Builder)

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Abstract. By implementing energy efficiency measures, the potential for energy savings in buildings is relatively large, bringing many economic, environmental, and social benefits. However, identifying truly effective solutions is challenging, and this study was conducted to contribute to addressing this issue. The research results identified the most impactful solutions for energy savings in buildings, with those related to selecting high-efficiency cooling systems and optimizing building envelope design ranking at the top. In addition, the study proposed a model for predicting the electricity consumption of buildings, based on the Random Forest (RF) machine learning algorithm combined with Building Information Modeling (BIM) simulation using the DesignBuilder software. The simulation model analyzed the energy performance of a sample building with parameters related to the solutions used in the building design process. The simulation data was then used as input for training and testing the prediction model using the Random Forest (RF) machine learning algorithm. This prediction model can be used in the initial design phase of the project by inputting the building's technical specifications to predict the electricity consumption, thereby enabling a comparison and evaluation of the effectiveness of energy-saving solutions for building design.

Evaluation of the Green Building Criteria in the Building for Ecologically Responsive Design Excellence (BERDE) Guideline through the Level of Importance of Sustainability Factors

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Abstract. From emissions to energy usage, the building sector has a substantial effect on the environment. Traditional building has been profoundly transformed by the sustainable construction movement. As a crucial component of the sustainable construction delivery system, sustainable/green building rating tools play a crucial role in incorporating sustainable concepts into the construction sector. The Philippine government recognized the National Voluntary Green Building Rating System, and numerous national agencies have used Building for Ecologically Responsive Design Excellence (BERDE) to design green building and sustainability policies and initiatives for the building industry. BERDE is often applied to tenants, buildings, and districts; it addresses design, construction, and operation. Although BERGE has been recognized for more than a decade, other countries are still using other Green Building Rating Schemes (GBRS). This study aims to identify the sustainability factor effect on BERDE integrating design delivery to satisfy local environmental concerns. The ideas deemed required by many key stakeholders are recommended to be utilized as the foundation for the future development of the BERDE User Guide after assessing the data received via the questionnaire. As result, the prioritization of some concepts over others is also recommended as it is deemed to be more suitable for usage for reviewing BERGE annually as identified, balanced, and realistic performance evaluation as a credible measurement of performance. Aside from sustainability goals, BERDE reforms include clearer purpose for all credits and enhanced advice on how projects can comply with the various standards in the future.

Keywords: green building, BERDE, level of importance, sustainability, GBRS.

Exploring the challenges of the implementation Technology 4.0 on enterprises operating in the construction sector in Vietnam

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Abstract. The fourth industrial revolution has been taking place recently. It has caused great impacts on the economic activities, life, and society of most countries in the world, especially the construction industry. Construction enterprises in Vietnam cannot remain inactive in the face of pressure from digital transformation, automation, and labor productivity improvement. This study identifies and analyzes the challenges to Technology 4.0 adoption in construction enterprises in Vietnam. Between November 2021 and December 2021, a survey was conducted with individuals and experts working in construction enterprises to collect the necessary information. Data were collected from 117 valid responses based on 19 impacts from the survey questionnaire. The study has identified six main challenges that Technology 4.0 brings, after conducting quantitative analysis with the support of SPSS software. The findings of the study will support enterprises proactively building appropriate implementation strategies to take advantage, boost productivity, as well as business activities towards sustainable development.

Keywords: Technology 4.0, Construction enterprise, Automation, Barriers, Challenges.

Exploring the Influential Factors for BIM Adoption Using the TOE Extended Framework

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Abstract. In recent years, the construction industry has changed rapidly with the development of digital technology. A new technology called Building Information Modeling (BIM) has emerged as multidimensional models to create, analyze, and communicate information. This technology has the potential to revolutionize the design and construction processes of projects. To motivate the adoption of BIM, the study on influencing factors has received much attention from many scholars. In this paper, 33 influencing factors including advantages, obstacles, drivers, and critical success factors were gathered from previous studies, which were classified into six key aspects for the application of BIM in the construction industry under the TOE expanded framework (Technology, Organization, Environment, Economic, Legal, and Human). These factors were ranked based on the occurrence frequency of factors synthesized from previous studies. The results show that culture of change, interoperability, standards, top management support, and cost of software are the most important factors influencing adoption of BIM. This contribution helps stakeholders focus on controlling the key factors and recommends solutions to encourage the use of BIM.

Keywords: adoption, BIM, factors affecting, TOE.

Factors Contributing to Using Green Construction Materials for Road Traffic Infrastructure Projects

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Abstract. The construction industry contributes to the consumption of 40% of generated energy, 30% of raw materials and 33% of global emissions that cause negative environmental impacts. Many previous studies in terms of evaluating the ability of green construction materials to replace traditional materials applied in the construction field have been numerous noteworthy accomplishments. However, the implementation and application of these achievements are still inadequate. This study collected information and analyzed data by analytical models to determine the correlation between groups of causes and the efficiency of the use of assessed green construction materials. Results showed that prices were the main dominant factor in using green construction materials in road transport infrastructure projects. The main reasons included the low level of technical requirements, the lack of vision, the development orientation of enterprises, coordination among stakeholders, the service life of construction works, maintainability, and factors of government policy and roadmap. In summary, the research results provided a more open approach to green construction materials in road transport infrastructure projects and contributed to the mass development of green construction materials in road transport infrastructure projects shortly.

Keywords: green construction materials, sustainable construction materials, infrastructure sustainable development

Generating 2D building floors from 3D point clouds

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Abstract. Terrestrial laser scanning (TLS) is an effective technology for rapidly capturing point clouds that visualize surfaces with high accuracy. Then, point clouds can be subsequently used to generate building information modeling (BIM). However, in practice, the technician spends time manually creating the model by using commercial software. Human carelessness can affect the quality of the model. This paper proposed a new method to automatically extract point clouds of floor slabs and a 2D drawing of the floor is subsequently generated for BIM generation. In this proposed method, a cell-based method is employed to extract data points from each slab. Then, the intersections between the slab and adjoined surfaces (e.g. walls, columns, and beams) are determined to identify a boundary of the slab. The proposed method is tested on a concrete building acquired from a construction project. The has 17 m long x7m width x 7m height, having 2 stories with several tens of million points.

Keywords: point cloud, floor extraction, as-built BIM, KDE.

Identifying the Frequency of BIM Model Information Needs to Establish a Database in the Operation Management Phase of High-Rise Buildings

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Abstract. It is imperative for the construction industry to implement new technologies and solutions. The common data environment is an outstanding opportunity for the Investor to enhance the efficacy of their projects during the industrial revolution 4.0. A substantial amount of research has been developed that investigates the advantages of Building Information Modelling (BIM) for the construction industry. However, it is unknown what challenges will be presented by the transition from conventional Facility Management (FM) methods to those based on BIM. It is crucial to clearly define the information of components in the facilities management phase. Therefore, the objective of this research is to determine the frequency of utilizing information on building elements during facilities management. This is considered to be one of the foundations to construct a database of BIM-FM models that is essential for the operation management unit. However, this database has not yet been reported and studied up to the present time. Based on the survey analysis, the research shows that the frequency and demand for information of the operation management unit focus on Mechanical and Electrical, not related to Architecture and Structural aspect. Research results can help stakeholders identify information that needs to be taken into mind in the handover process the high-rise building facilities management and operation unit.

Keywords: building information modeling, facility management, operation management phase, high-rise buildings, component information.

Implementation Status and Recommendation of Construction Waste Management Policies and Regulations in Vietnam

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Abstract. Construction waste management (CWM) has attracted positive attention from researchers due to its environmental and social benefits. Several studies have revealed that construction and demolition waste generation has been rapidly increasing, while the CWM in practice is ineffectively performed in many countries, especially in Vietnam. The inefficiency of practical CWM in developing countries may be related to local regulations and policy issues. Therefore, the suitability between CWM regulations and practices has emerged as an urgent demand for society. This study aims to reveal the status of CWM policies and regulations in Vietnam and to contribute recommendations of CWM to the Vietnamese authorities based on existing experiences of several developed countries (the United States and the European Union) and developing countries (China, India, and Vietnam). The content analysis technique was done by obtaining information about regulations, policies, and studies in terms of CWM in various developed and developing countries, and thereby analyzing the characteristics of the CWM processes. Two findings of this study included (i) although the Vietnamese CWM policies and regulations are at the national level, these legal documents do not provide sufficient support for local in implementing CWM, and (ii) CWM implementation experiences in the developed countries may be adapted to orient Vietnamese CWM policies and regulations for implementation at local levels. In conclusion, this study was considered as advice for authorities and the construction industry in Vietnam to improve CWM performance in practice.

Keywords: Construction and Demolition Waste, Content Analysis, Waste Management, Policies, Regulations.

Infrastructure Model Development to Enhance Resilience Against Future Changes Using InfraWorks & GIS

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Abstract. The Smart City idea is becoming more popular because cities are getting too crowded. This study looks at how BIM and Geographical Information Systems (GIS) work together. The study focused on infrastructure and figuring out how long a building would last, as early stages of infrastructure development would help the public organization to better plan and design. The GIS mapping shows which areas are more likely to become cities or towns. The AEC industry stakeholders can benefit from mapping to achieve Sustainable Development Goals (SGDs). The AEC industry has also been constantly moving towards Building Information Modelling (BIM). In this study, the city of London was considered, and Land Cover predictions from 2000 to 2025 were made. The predicted Map of 2025 would help developers and planning authorities on decision making on housing development. Based on the current study, more research could be extended on how BIM and GIS could work together for urban development.

Keywords: smart city, GIS, BIM, infrastructure management.

Integrating Bim and Gis Data to Support the Building Management

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Abstract. Nowadays, construction is becoming increasingly large and complex, with construction technologies, methods, and the like developing rapidly. Construction projects generate various types of information. Moreover, the manager needs to have a general view of all construction to make decisions, especially for developing a smart city. To satisfy the requirements of project system management, the integration of BIM and GIS is an indispensable requirement. BIM (Building Information Modeling) is a system of steps for building spatial and attribute data for managing digital features in design and quality monitoring. GIS (Geographic Information Systems) is a general geographic information storage system for decision-making in planning, land use management, archiving administrative data, etc. Although the application of GIS has a long history, and BIM has also developed for over ten years, the integration between BIM and GIS is still in the research process. In this study, the authors will consider integrating BIM and GIS into two independent constructions to create unity in managing the building system associated with urban development.

Keywords: BIM, GIS, smart city. building management.

Machine Learning - Based Predictive Models for Energy Consumption Estimation in Energy-Efficient Building Envelope Design

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Abstract. In recent times, the construction of energy-efficient buildings has become increasingly necessary. Estimating the energy consumption of a building, considering envelope parameters such as wall type, glass type, window-to-wall ratio, orientation, etc., at an early stage is crucial for project managers. Currently, there are estimation methods based on experience using mathematical formulas or simulations on specialized BIM software. However, initial estimates are often inaccurate due to the lack of detailed BIM models, which is time-consuming and problematic. This research utilizes various machine learning techniques, including Support Vector Machine (SVM), Artificial Neural Network (ANN), Generalized Linear Regression (GENLIN), Deep Learning Neural Network (DLNN), Random Forest (RF), and Gradient Boosting (GB), to predict the preliminary energy consumption for a building. The machine learning models were trained and tested on data collected from simulations using BIM-Design Builder software. The comparative results demonstrate that Gradient Boosting, an ensemble learning technique, outperforms all other machine learning algorithms in terms of accuracy and performance. Based on these findings, energy estimation experts can efficiently select the best model for predicting the preliminary energy consumption of a building by employing diverse estimation methods.

Keywords: energy consumption estimation, building envelope, machine learning (ML), support vector machine, ANN, generalized linear regression, deep learning neural network, random forest, gradient boosting.

Metaverse Immersive Virtual Reality Enhances Multiple Collaboration in Construction Design Review Phase

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Abstract. This research aimed to develop and assess a multi-user real-time virtual reality (VR) application performed during the construction design review phase. Corresponding to clarifying the design review sessions held amongst participants in different locations, therefore, establishing a common data environment (CDE) for all stakeholders. Moreover, the article outlines a process to construct a real-time multi-user immersive VR application constructing a multi-user immersive VR application in real-time to facilitate remote cooperation, the immersive VR application is designed to outperform the conventional method it is been determined by the proportion of design error found during building inspection tests. Bringing together remote stakeholders in a virtual environment has hindered the implementation of VR technology in the architecture, engineering, and construction (AEC) industry. Several past multi-user VR studies have been undertaken in other industries, but there is a dearth of comparable research in the AEC business. This study adds to the AEC industry by describing the creation of multi-user immersive VR apps for real-time remote collaboration and providing empirical data to illustrate the advantages.

Keywords: virtual reality, collaboration, multi-user, design review phase.

Optimizing Envelope Design and Window Performance for Energy-Efficient Buildings through Integration of Building Information and Energy Modeling (BIM-BEM)

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Abstract. Building energy efficiency is an important consideration for both new and existing buildings. Windows play a significant role in the energy efficiency of buildings, as it can be a major source of heat loss or gain. The window design can have a significant impact on a building's energy performance, as it affects the amount of solar radiation that enters the building and the amount of heat that is lost through the envelope. Therefore, it is an important consideration in building design, particularly for energy-efficient buildings. To reduce a building's Energy Use Intensity (EUI) and energy costs during its construction process, energy simulation and optimization models can be used in combination with window design (window-to-wall ratio, glazing properties) through a Building Information Modeling (BIM) and Building Energy Modeling (BEM). Using Autodesk Insight 360 with BEM is a powerful tool that can aid in the optimization of building designs and the reduction of energy consumption. The integration of these techniques can assist architects and building managers in evaluating the window design to improve the energy efficiency of buildings.

Keywords: window design; building information modeling; building energy modeling, energy-efficient buildings.

Optimizing Project Resources Using the Hybrid Multi-Objective Algorithm and Decision-Making Method

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Abstract. Schedule, cost, quality control, and rational use of labor and resources are key factors that project management aims to achieve, and these factors have a complex relationship with each other. However, almost all existing trade-off analysis models have only focused on addressing the time-cost issue without simultaneously considering the impact of collision activities on quality costs. Moreover, the results will be influenced by several external elements that are uncertain and hard to identify, such as weather conditions, machine and equipment capability, and labor efficiency, among others. Therefore, this research aims to develop an optimal model of project resource balance with quality considerations (TCQT) by applying fuzzy logic, the multi-objective social group optimization (MOSGO) algorithm, and the multi-criteria decision-making method (MCDM), while also considering the uncertainty of input variables. In this paper, fuzzy logic is used to select input and defuzzification to filter the results according to various factors. Additionally, the MOSGO algorithm is applied to determine a set of Pareto-optimal time-cost-quality curves, and multi-criteria decision-making methods are used to obtain the best outcome. The expected research outcome is the introduction of an optimization model that combines SGO, fuzzy techniques, and MCDM to optimize problems requiring resources along with quality control (TCQT) and integrate uncertainty that occurs in actual large-scale projects.

Keywords: fuzzy logic, hybrid multi-objective, social group optimization, time – cost – quality trade-off, uncertainty.

Photogrammetry-based Building Scan using Ultra-lightweight Drone for Urban Applications

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Abstract. Several studies have reported how to apply drones in photogrammetry. However, most of them use specialized ones which leads to difficulties such as obtaining flight licenses, pilot limited skills, and take-off and landing spaces. In a previous study, the authors demonstrated the feasibility of using a ultra-lightweight, small-sized drone, also known as mini drone (a type of non-specialized photogrammetry drone), to create a digital twin model. At this time, we use DJI Mini 2, which is a cheaper drone with lower image quality than last time. However, thanks to the perfecting of the flight plan, the resulting building digitization guarantees to fulfill the visualization purposes. This article will introduce unmanned air vehicles (UAV) - photogrammetry step by step while discussing the use of mini drones in the data acquisition process, and present a specific case study.

Keywords: UAV - photogrammetry, mini drone, digital twin.

Proposing Criteria to Evaluate The Effectiveness of BIM Application in the Payment of Construction Projects in Vietnam

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Abstract. In the construction industry, Building Information modeling (BIM) has been recognized as the advanced technology for changing and improving the construction process. Especially for investors and contractors, the BIM technology has been applied for checking the clash among building elements in the design process and for modeling the construction progress. However, the application of BIM to construction project payment has not emphasised strongly in Vietnam. The implementation process to replace the BIM model for the traditional payment method is facing many obstacles. This study aims to analyze the potentials and benefits of applying the BIM in payment. The quantitative and statistical analysis was performed based on data collected from a questionnaire survey of stakeholders who have experience in the BIM application and construction payment. Then, this study proposes criteria to evaluate the effectiveness of the BIM application in construction project payment. The research supports state agencies and businesses in BIM excution planning (BEP) in general and payment process in particular.

Keywords: BIM; construction project; payment; effectiveness; criteria.

Ready Mix Concrete Truck Dispatching Optimization on A Mobile Application

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Abstract. Dispatching ready-mix concrete (RMC) trucks still follow the traditional method. Each batching station has a dispatcher to manage and monitor the vehicle via walkie-talkie and telephone. However, this method is quite time-consuming and can cause mistakes or make the whole process ineffective. In addition, it puts pressure on the dispatcher to receive and handle a large number of phone calls. Therefore, there is a need for a smart application that helps managers come up with the optimal dispatching schedule without manually processing it. Although there were many studies in the literature about RMC truck dispatching schedules using swarm intelligence optimization algorithms. Yet, none has presented it in a convenient and easily accessible interface for users. So in this study, we proposed an application installed on mobile devices that uses input data about the demand for concrete to be transported, the timeline, the location and the transportation distance, etc., to provide the RMC truck dispatching optimal schedule.

Keywords: Ready mix concrete dispatching, optimization algorithm, swarm intelligence, mobile app.

Review of the Application of Machine Learning in Construction Handle Equipment Safety Management

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Abstract. Accidents caused by using personal construction equipment on construction sites are a matter of concern and frequent occurrence. The prediction and management of the safety of personal construction equipment are mainly based on visual assessments and checklists. However, this is time-consuming and not very effective in management. In recent years, machine learning, such as natural language analysis and machine vision, has been widely applied in analysis and prediction and early warning in construction equipment management. In this study, we synthesize, analyze, and provide a comprehensive review of studies applying machine learning to equipment management on construction sites. The results indicate that machine learning has a lot of potential in the management, life prediction and maintenance schedule for these devices. Moreover, in collaboration with other technologies, machine learning models such as computer vision also play a supporting role, increasing the automation level of safety management work on site.

Keywords: construction equipment managements, construction safety, Machine learning, construction management.

Risk Management of Pre-Engineered Steel Buildings Using ATOM Methodology

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Abstract. Nowadays, pre-engineered steel building projects are built a lot because of the advantages of saving progress and costs. During the construction process, there are always hidden risks related to quality, safety and progress. There are too many risks for the project which it will be greatly difficult to manage. To overcome the consequences and incurred costs that managers need the plan and measure the risks. Therefore; in this study, we proposed to use the ATOM method (Active Threat and Opportunity Management) to manage risks and build risk prevention measures at the lowest level. The ATOM method is a comprehensive process that includes the steps of risk identification, assessment, analysis - response planning; practical application and finally evaluate and change the process.

Keywords: steel building, ATOM, risk management, construction management.

The Cost Estimating Model for Façade System of High-Rise Building in the Concept Phase by Using CBR Method

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Abstract. Facade value is one of the important factors in a construction estimate. Normally, the value of facade accounts for about 20-30% of the total cost of construction estimates of a project. And this percentage can fluctuate depending on many factors such as type of work, project size, construction site, quality of materials, construction items and complexity of the works. Therefore, reasonably accurate cost estimation of the facade value in the construction estimate is very important, especially the cost estimate at the early stages of the design process of a construction project. However, the prediction of cost quite difficult due to the numerous interactions among the many variables. Artificial neural networks (ANN) and case-based reasoning (CBR) are assessed to overcome this difficulty. This paper only focuses on CBR model augmented by genetic algorithms (GA). GA was used to determine the optimum weights. The cost data of thirty-six actual cases of residential building projects were used as a case study.

Keywords: case-based reasoning (CBR), estimating construction cost, genetic algorithm (GA), the façade system,

The Implementation Process of Scan to BIM Project Establishment and Applying It to Case Study of Thermal Power Station

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Abstract. In recent decades, Building Information Modeling (BIM) has become a prevalent technology in the civil engineering and asset management sectors. Accurate visual and attribute information in BIM-models are crucial for a successful BIM execution, particularly throughout the operation and maintenance phases of an asset's life cycle. On the other hand, the building information included in BIM models may have errors, be out of date, or be entirely absent from real-world projects. The method of using 3D laser scanning to record the accurate as-is state of buildings and construct as-is BIM models of such structures is known as scan-to-BIM. The Scan to BIM implementation processes that current researchers are pursuing are still at a general level, or they are going into the process of using equipment and software without mentioning the concept of Level of Accuracy (LOA), or there is no general process for the implementation of Scan to BIM projects for thermal power stations (TPS). The framework is oriented toward the specific Scan to BIM application to be implemented using the created as BIM, which includes synthesizing fundamental concepts when applying Scan to BIM for establishing the process and establishing a Scan to BIM project implementation process with the TPS case study. In addition, the research applies the recommended technique to a real-world project to evaluate its applicability and effectiveness. Results indicate that the established quality criteria may be successfully implemented when selecting the suitable scanning process for Scan to BIM detection.

Keywords: scan to BIM, thermal power station (TPS), BIM, level of accuracy (LOA), 3D laser scanning.

Understanding the Determinant of Technology Innovation in Construction Management: An Empirical Study in Vietnam

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Abstract. Technology innovation in construction management has gained immense attention in recent years. The application of innovative technologies assists project managers to improve the productivity of construction job sites and discover potential performance issues. However, the technology innovation rate is still relatively slow in Vietnam. Thus, this research utilized Technology Acceptance Model 3 (TAM3) to investigate determinants that promote technology innovation in the Vietnam construction industry from the technical, organizational and environmental dimensions. To achieve research goals, the study distributed a questionnaire survey to 184 construction professionals to collect data, then employed Exploratory factor analysis (EFA) to develop the TAM3 model. The TAM3 model results show that perceived adoption cost, compatibility, competitive pressure, technology maturity, organization readiness and policy have impacted the adoption intention of emerging technology in the construction industry through perceived usefulness and perceived ease of use. Wherein perceived adoption cost has a significant impact on the perceived usefulness. The research results contribute to a better understanding of factors that influence technology innovation in construction and provide data for governments to formulate technology transformation roadmap for the Vietnam construction industry.

Keywords: smart technology, TAM, construction management, influence factor.

Using “Choosing By Advantages” Method yo Select Contractor for Design and Build Projects Toward Sustainable Construction

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Abstract. Contractor selection in Design and Build (D&B) projects that is not based on a comprehensive evaluation process will lead to undesirable situations affecting the project in many ways, from not promoting the advantages of the D&B model, extending the schedule, increasing project costs, reducing quality, causing great damage to the Investor. Multicriteria decision-making (MCDM) methods can help the project managers to select the best bidder. The main contribution of this study is to propose a comprehensive evaluation process of contractor's capacity based on Choosing by Advantages (CBA) method in D&B projects that considers the sustainability in construction. Actually, sustainable construction has become more and more important nowadays because it is not only related to environment protection but also to the business strategy of Employer. Data collected from documentation as well as in-depth interviews and surveys have been analyzed to determine the key factors that affect the decision of selecting a contractor. This research also explains why CBA is superior other MCDM methods, for this context.

Keywords: choosing by advantages (CBA), design and build (D&B), multicriteria decision-making (MCDM) methods, sustainability, bidding evaluation.

Construction Material Session

A Review of Current Progress and Application of Machine Learning on 3D-Printed Concrete

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Abstract. 3D-printed concrete is a special type of concrete that is digitally fabricated based on 3D-printing technologies without vibration and formwork. Different from conventional concrete, the quality of 3D-printed concrete is significantly affected by the fabricating process and is evaluated by more complex parameters such as extrudability, buildability, open time, shape stability, etc. Statistical and empirical models have been to predict the properties of concrete mixtures and structures and support printing processes. However, developing these models requires laborious experimental work and may provide inaccurate results when the complex relationships between the evaluation parameters of concrete mixtures and printed elements. Therefore, machine learning (ML) has become a potential solution in material optimization, manufacturing process management, and behavior prediction for concrete mixes and printed structures. Although advances in ML provides an opportunity to design and optimize 3-D printed structures and materials and achieve more cost-effective and sustainable designs, the number of studies applying ML in 3D printed concrete remains limited. Most of the research on 3-D printed concrete has so far been experimental, with little focus on computational simulations and prediction for the 3-D printing process. There is even a lack of published information on ML simulation and modeling. In this review, the applications of ML and its performance are critically discussed and analyzed, thereby identifying practical recommendations, current knowledge gaps, and needed future research.

Keywords: 3D printed concrete, addictive manufacturing, machine learning, three-dimension printing, prediction of concrete properties

A Study on The Factors of Classification Recycling of Construction Demolished Waste (CDW) in Ho Chi Minh City

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Abstract. Construction demolition works have a large volume and increase gradually with the socio-economic development. But they have not been given due attention. Because the effectiveness of management of construction demolished waste (CDW) has impacted the environment, we should pay attention to it in general or in part. The way should be in a harmonious balance with other activities. This study analyzed the causes affecting the classification and recycling of CDW. Next, the paper introduced economic problems related to recycled sand from waste concrete. The last result proposed solutions for classification and recycling for Ho Chi Minh City. The data was collected through a survey from organizations related to the existence and transformation of CDW with different positions and working periods. The results indicated eight factors. The first related to the problem of infrastructure and technology not developed enough to meet demand of CDW classification and recycling. Recycled sand from CDW has difficulties and barriers in the market. On-site testing and processing are still difficult to conduct in Vietnam. CDW relevant regulations are not complete and strengthened. The quality of construction used recycled sand from CDW is still not good and safe. The initial management process of CDW is not optimized. Consumption ability of recycled sand from CDW is not good. The paper also proposes various solutions for CDW classification and recycling in Ho Chi Minh City

Keywords: construction demolished waste, classification, recycling, policy.

Applicability of Electrical Resistance Method for Water Absorption Test on Cement Paste Using Mineral Admixture

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Abstract. While moisture is essential for the reaction of the binder in concrete, it is also known to be closely associated with degradation factors. Therefore, it is important to understand the internal water transfer for the maintenance and management of concrete structures. The gravimetric method, which involves destruction, and the electrical resistance method, a nondestructive test, are commonly used to measure moisture transfer. An embedded electrical resistivity method, one of the electrical resistivity methods, can finely grasp the moisture state in cement paste by the miniaturization of the electrode. However, its reproducibility and accuracy are still unclear, and it cannot be said to be a well-established method. It is also known that the pore structure becomes dense and the electrical resistance changes when mineral admixture is used because the electrical current flows through non-bonded water in hardened cement paste. Although the use of concrete with mineral admixtures has been increasing, there are still few examples of detailed studies on water transfer in this case. This study aims to examine the reproducibility and accuracy of the embedded electrical resistance method, and the results of the water absorption test using the electrical resistance method and the gravimetric method were compared by using cement paste with and without mineral admixtures. As a result, for almost all the mixture proportions, the moisture arrival distance at each measurement time measured by both methods was almost the same. It may indicate that the electrical resistance method is applicable as a moisture transfer measurement method.

Keywords: electrical resistance method, gravimetric method, relative moisture content, water absorption process

Characterization of High-Volume Fly Ash Cement Pastes

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Abstract. Designing construction and building material containing recyclable resources have become a potential demand for sustainable development. The main objective of the research is to create an ultra-high volume fly ash cement paste (HVFP), which incorporated a significant proportion of fly ash (FA) to substantially replace Portland cement (PC) for ecological purposes. In this research, the dry density, compressive strength, water absorption, drying shrinkage, and chloride ion penetration (CIP) examinations were performed on mix designs assembled from various FA fractions (0, 20, 40, 60, and 80%) as a partial substitution of PC. Based on the laboratory findings, incorporating 20% FA in HVFP formulations can achieve comparable bearing capacity at all cured ages as a reference mix. Among all HVFP mixtures, specimens containing 20% FA exhibited the greatest compressive strength value of 70.92 MPa at 120 days, while the 80% FA samples exhibited the weakest load-carrying capacity of 39.28 MPa. The finding was consistent with the test results of the dry density and water absorption experiments since the optimized engineering characteristics may be attained by keeping the FA consumption below 20%. In addition, the ion charging conveyed across the HVFP mixture can be mitigated by utilizing an adequate FA concentration (20%), contributing to an equivalent in resistivity compared to the reference mixture. The analysis findings also demonstrated a strong correlation between water absorption and CIP levels because a lower porosity value can lead to a denser framework and restrict chloride ions from migrating via the specimen. Besides, replacing the PC with high-volume FA was beneficial in reducing the drying shrinkage of the HVFP. Overall, the FA concentration of HVFP can be modified to an ideal level of lower than 20% to encourage ecological growth objectives and accomplish acceptable performance.

Keywords: high-volume fly ash, cement paste, compressive strength, drying shrinkage, water absorption, chloride ion penetration.

Durability and Microstructure of High-Strength Mortar Produced with High Loss-On-Ignition Fly Ash and Silica Fume

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Abstract. To save natural resources and protect the environment, the use of fly ash (FA) with a high loss on ignition (LOI) and silica fume (SF) in producing high-strength mortar (HSM) is the objective of this study. The effect of FA with high LOI on the durability and microstructure of HSM was investigated. All HSMs were designed with a water-to-binder ratio of 0.24, and the amount of SF is 20% total amount of binder materials. The reference mixture was designed without FA, while four others were created by using FA to replace 15%, 30%, 45%, and 60% cement. Test results indicated that the mortar quality was decreased with increasing high FA content. However, with the presence of SF, all mortars in this study still showed good quality with compressive strength of above 50 MPa and rapid chloride ion penetration value of below 1000 Coulombs. Many free-FA particles and impurities, which were observed in the scanning electron microscopy image of HSM samples with high FA content, are causes leading to a reduction in the mortar quality. In addition, the relationships between some properties of HSM were also established.

Keywords: high-strength mortar, fly ash, high loss on ignition, durability, microstructure.

Effect of Aggregate Grading and Steel fiber on the Properties of Ultra-High Performance Fiber Reinforced Concrete

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Abstract. Coarse aggregate is one of the factors affecting the workability and compressive strength of Ultra-High-Performance Concrete (UHPC). In addition, adding steel fiber into UHPC constituents enhances the toughness of the material under tensile stress. However, the content of steel fiber also affects the workability and mechanical properties of the material. In the present study, quartz sand and crushed stone were used for aggregate and the steel fiber content was used at 1.0; 1.5; 2.0, and 2.5% by volume, respectively. The mechanical properties of concrete including compressive strength, elastic modulus, flexural strength, and tensile strength were conducted by experiment program. The findings showed that coarse aggregate and steel fiber also influence the workability of UHPC. The content of steel fiber slightly affects the compressive strength but significantly affects the flexural strength of concrete. Moreover, the addition of 2.5% steel fiber content leads to a significant decline in the properties of both fresh and hardened concrete.

Keywords: ultra-high-performance concrete, coarse aggregate, steel fiber, fracture energy.

Effect of Artificial Coarse Aggregate from Fly Ash Activated by Calcium Sulfate Dihydrate on Compressive Strength and Water Absorption of High-Strength Concrete

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Abstract. The present study focuses on investigating effect of artificial aggregates from fly ash activated by calcium sulfate dihydrate as a partial crushed stone replacement, on bulk density, compressive strength, and water absorption of high-strength concrete (HSC). The artificial fly ash aggregate (AFAA) was made from a mixture consisting of 85% Class-F fly ash, 15% Portland cement, and 0 or 2% calcium sulfate dihydrate ($CaSO_4.2H_2O$) as an activator and having a low water-to-binder ratio of 0.2. The replacements of crushed stone by the AFAA were 0, 20, 40, and 60% by volume. All the mixture proportions of HSC had a low water-to-cement ratio of 0.37. All the concrete samples were cured in water at a temperature of 28±2°C. The results showed that although bulk density of hardened concrete containing AFAA was lower than that of the control concrete without AFAA, the value was in a range from 2229 to 2429 kg/m^3. The partial replacement of crushed stone by AFAA in the range of 20–60% decreased the compressive strength of hardened concrete by 7.9–31.4% when compared with the control concrete at the age of 28 days. The AFAA replacement increased the water absorption of all the concrete samples by 15.7–66.2% compared with control concrete. The hardened concretes with 20% replacement of AFAA activated by 2% $CaSO_4.2H_2O$ had the highest compressive strength at all ages and the lowest water absorption at 28 days among the ones with AFAA replacements.

Keywords: artificial fly ash aggregate, bulk density, calcium sulfate dihydrate, compressive strength, water absorption.

Effect of Artificial Fly Ash Coarse Aggregate on Bulk Density, Water Absorption, and Compressive Strength of Lightweight Concrete

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Abstract. In recent years, lightweight concrete (LWC) has been extensively used in construction due to its benefits for reducing static loads, insulating against sound and heat, and so on. The LWC is typically produced by using natural and/or artificial lightweight aggregates (LWA). In this study, artificial fly ash coarse aggregate (AFCA) was produced through the cold bonding technique from a mixture of fly ash, Portland cement, and sodium silicate (Na_2SiO_3) as an activator. This study aims to assess the effect of AFCA on bulk density, water absorption, and compressive strength of the LWC. The AFCA was added to the concrete mixture by substituting 0, 50, and 100% by the volume of LWA. Expanded clay aggregate (ECA) as an LWA was also added to the reference concrete mixture for comparison purpose. Results showed that the replacement of ECA with AFCA gave positive results in which the compressive strength was increased from 17.0 to 47.7% and water absorption was decreased from 19.3 to 56.7% compared with those of LWC with 100% ECA. Although the bulk density of concrete with AFCA was slightly higher than that of LWC with 100% ECA, its value was still less than 1800 kg/m^3 for all the mixtures considered as the LWC. In summary, the AFCA in this study could be used as the LWA to produce the LWC with improved compressive strength and water absorption.

Keywords: activator, fly ash coarse aggregate, lightweight aggregate, lightweight concrete, sodium silicate.

Effect of Coal Gasification Slag on Mass Transfer Resistance of Concrete

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Abstract. Coal gasification slag (CGS) is discharged as a by-product of the integrated coal gasification combined cycle which is a new generation technology that improves power generation efficiency compared to conventional coal thermal power generations and reduces carbon-dioxide emissions. The CGS has been attracted as a fine aggregate in concrete and was established as a new fine aggregate by Japanese Industrial Standards (JIS) in 2020. On the other hand, although it has been suggested that CGS may have a reactivity similar to mineral admixtures, it has not been clarified yet and research on the contribution of CGS to the resistance of concrete is insufficient. This paper has focused on a series of concrete experiments using CGS as a fine aggregate to explore the mass transfer resistance of concrete, based on carbonation resistance and surface air permeability. Two mixture proportions with a water-to-cement ratio of 0.55 were prepared with CGS from the Nakoso power plant (CGSC) and the conventional fine aggregate (NC) as fine aggregate. The unit water content for the CGSC and NC were optimized to get the target slump and air content and they were 162 kg/m^3 and 172 kg/m^3 respectively. All the concrete specimens were cured under the condition of two curing methods; 7d-sealed where the specimens were stored at 20±2ºC and 60±5%RH after sealing at 20±2ºC for 7 days, and 28d-water where they were stored at 20±2ºC and 60±5%RH after curing in water at 20±2ºC for 28days. As a result, CGSC has an equal or better carbonation resistance, especially in 28d-water curing, and an equal or lower surface air permeability resistance than NC.

Keywords: coal gasification slag, fine aggregate in concrete, carbonation, surface air permeability, curing condition.

Effect of Disposable Medical Facemask Fiber Content on Strength, Impact Resistance, and Water Absorption of High-Strength Concrete

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Abstract. Human health is a major focus of the international public reaction to the COVID-19 (SARS-CoV-2) pandemic. An increasing usage of medical facemasks has warned of significant threats to the environment. Therefore, it is crucial to utilize these masks to lead to an environmentally sustainable development. This study focuses on evaluating the effect of disposable medical facemask (DMFM) fiber content on compressive and flexural strengths, impact resistance, and water absorption of high-strength concrete. The amounts of DMFM fibers were added at 0, 0.3, and 0.5% by volume of concrete, along with polypropylene (PP) fibers applied at the same dosage for comparison. A ratio of water-to-cement was kept constant at 0.37 for all the mixture proportions. The results showed the addition of DMFM fibers did not affect the compressive strength of hardened concrete at all curing ages; however, it decreased the flexural strength. All mixture proportions still achieved the designed compressive strength of high-strength concrete (i.e., above 70 MPa). The concrete samples containing DMFM fibers resulted in higher impact resistance and water absorption than the reference concrete samples without fibers. When comparing with DMFM fiber reinforced concrete, the use of PP fibers showed more effectively for compressive and flexural strengths, impact resistance, and water absorption of hardened concrete. In general, in this study, 0.3% DMFM fibers would be an optimal amount, which can significantly improve the impact resistance of hardened concrete.

Keywords: compressive strength, disposable medical facemask fiber, flexural strength, impact resistance, water absorption.

Effect of Fly Ash as a Partial Replacement for Sand on Sulfate Resistance of Mortar

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Abstract. The quality of fly ash, which is a by-product of the thermal power plants in Vietnam, is not high due to a high loss on ignition content. So, the utilization of the fly ash used in concrete has not been much. Nowadays, the shortage of natural sand is serious affecting negatively on developing construction period in Vietnam. Therefore, this study investigates the effect of fly ash as a partial replacement for sand on the sulfate resistance of mortar. The replacing ratios are 0%, 10%, and 20% by volume of fine aggregate. Strength and expansion of mortar due to sulfate attack were examined. To clarify the effect of fly ash as a fine aggregate on mortar, the total porosity was determined and the portlandite content was determined by TGA analysis. The test results show that the compressive strength of mortar was enhanced by using fly ash when submerged in both water and sodium sulfate solution. The expansion of mortar was reduced when the rate of used fly ash as fine aggregate increased. There are three reasons to explain the test results. The first, fly ash as a fine aggregate shows a filling effect on the mortar. It makes mortar structure denser and results in the improved compressive strength and reduced expansion of mortar. The second, the use of fly ash leads to the lower w/b ratio. It also improved the performance of mortar. And the third, fly ash has pozzolanic reaction. This reaction consumes amount of Ca(OH)2 form the cement hydration. It inhibits the sulfate reaction, especially the sodium sulfate attacking Ca(OH)2.

Keywords: mortar, fly ash, sulfate resistance, compressive strength.

Effect of Polyethylene Terephthalate Percentages in Asphalt Concrete by Using Modified Dry Mixing Method

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Abstract. In Vietnam, there are fewer research on the utilization of Polyethylene Terephthalate as an additive in asphalt. To be used widely, it is essential to do specific and completed studies on improving the efficiency of mixing Polyethylene Terephthalate and asphalt binder. The study is database for reference and evaluation of subsequent synthetic Polyethylene Terephthalate studies in Vietnam to propose the solution of mixing Polyethylene Terephthalate and asphalt binder by dried method and find out the optimum content of Polyethylene Terephthalate. The study used Polyethylene Terephthalate granules mixed with asphalt mixture at many rates of the total weight of aggregate. The properties of hot mix asphalt, which nominal maximum aggregate size is 12.5mm, are evaluated through laboratory tests such as Marshall stability, indirect tensile strength, and static resilient modulus test.

Keywords: polyethylene terephthalate, marshall Stability, indirect tensile strength, static resilient modulus, dynamic modulus.

Effect of Sodium Sulfate Content on Engineering Properties of Artificial Aggregate Made from Cement and Fly Ash

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Abstract. This paper presents an experimental investigation in terms of sodium sulfate (Na_2SO_4) content effect on engineering properties of artificial aggregate made from Portland cement and a high amount of fly ash (i.e., artificial fly ash aggregate - FAA). The FAA was formed by a cold method with three ratios of fly ash-to-binder of 85%, 90%, and 95%, and several Na_2SO_4 contents of 0%, 1%, 2%, 3%, and 4% by mass of binder. After curing in water for 3, 7, and 28 days, the engineering properties including compressive strength of the FAA matrix, water saturation, crushing value, and density under saturated surface dry (SSD) condition of FAA were tested to find out the optimal fly ash-to-cement ratio and Na_2SO_4 content for FAA fabrication. The results showed that using Na_2SO_4 as an activator significantly improved the compressive strength of FAA matrix. Most of the FAA matrix using 2% Na_2SO_4 showed the significantly improved compressive strengths at 7, 14, and 28 days, while the FAA matrix with the ratio of fly ash-to-binder of 85% and 4% Na_2SO_4 gave the best compressive strength results at 14 and 28 days. When compared with the crushed stone, the water saturation of FAA was significantly higher about 12–27 times, its crushing value was 2–4 times higher, whereas its density in the SSD state was lower by 16.60–22.22%. In conclusion, the FAA made from 15% Portland cement and 85% fly ash activated by 2% Na_2SO_4 in this study had the acceptable engineering properties to partially replace the crushed stone in the concrete production.

Keywords: artificial fly ash aggregate, compressive strength, crushing value, sodium sulfate, water saturation.

Effects of Soaking Time and Na_2SO_4 Concentration on Engineering Properties of Recycled Concrete Aggregate Treated by Using Cement – Fly Ash Slurry

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Abstract. The exploitation of natural resources provides raw materials for construction such as river sand, crushed stone, and so on. They are non-renewable resources and overexploitation causes them to gradually deplete. Besides, breaking up buildings for various purposes creates a large amount of construction and demolition waste (CDW), which occupies most of the landfill sites. As a result, the replacement of crushed stone in concrete with recycled concrete aggregate (RCA) from CDW is necessary. However, the engineering properties of concrete using RCA are worse than those of concrete using crushed stone. The aim of this study was to investigate the effects of soaking time and Na_2SO_4 concentration on engineering properties of RCA treated by using cement – fly ash slurry to evaluate the effectiveness of this technique for improving the properties of RCA. In this study, the RCA had several types including untreated RCA (0RA), RCA treated in a slurry of cement and fly ash for 48 hours (TRA), RCA treated in a slurry of cement, fly ash, and 2% Na_2SO_4 for 24 hours (2TRA24N) or 48 hours (2TRA48N), and RCA treated in a corresponding slurry with 4% Na_2SO_4 for 24 hours (4TRA24N) or 48 hours (4TRA48N). The results showed 4TRA24N had crushing values and water absorption which were thought to be optimal as compared to other untreated and treated RCAs. The higher the soaking time and Na_2SO_4 concentration, the lower the crushing values and water absorption of treated RCA. In summary, soaking time of 24 hours and a slurry of cement, fly ash, and 4% Na_2SO_4 were the optimum solution for improving the engineering properties of RCA.

Keywords: activator, crushing value, density, recycled concrete aggregate, water absorption.

Experimental Investigation on Diffusion Coefficient of Reinforced Concrete Structures in Sea Island Regions of Khanh Hoa

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Abstract. Corrosion of steel rebars in reinforced concrete (RC) structure is the main cause of concrete damage in maritime regions because of high content of chlorine ions. The penetration of chlorine ions through concrete cover is characterized by the diffusion coefficient D. According to recent research, the diffusion coefficient D depends on many factors of concrete material (cement, additive, ratio of water/cement (W/C ratio)) and concrete age. This important parameter of RC structure is necessary to predict its service life of structures in sea zones of Khanh Hoa. For this reason, in this article, experimental investigation is carried out in order to provide diffusion coefficients for RC structures in sea island regions of Khanh Hoa (Viet Nam). The in-situ RC concrete samples are extracted and experimental data on diffusion coefficient at corresponding age (Dt). Based on this experimental data, the empirical time-dependence of diffusion coefficient (Dt) is proposed for RC structures in Khanh Hoa regions.

Keywords: chloride ion measurement, diffusion coefficient, reinforced concrete, corrosion by chlorine ion penetration, experimental investigation.

Facile Fabrication of Waterproof and Flame-retardant Microfibrillated Cellulose Aerogels from Pineapple Leaves for Acoustic Insulation

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Abstract. Cellulose aerogels have been recently studied for acoustic insulation due to their capability of absorbing sound energy effectively. However, one of their main drawbacks is hydrophilicity and flammability hindering their long-term storage and applicability. This work develops water-resistant, flame-retardant, and sound-absorbing aerogels from discarded pineapple leaves via a facile and eco-friendly route. Cellulose microfibers are obtained from the leaves by two stages of alkaline pretreatment and mild acid hydrolysis associated with high-speed homogenization. The fibers are then mixed with polyamide amine-epichlorohydrin as a cross-linker and ammonium polyphosphate (APP), followed by freeze-drying, annealing, and methyltrimethoxysilane coating to produce final cellulose aerogels. Effects of fiber composition, solid content, APP content, and coating condition on porous structure, flame propagation speed, hydrophobicity, and sound absorption of the aerogels are investigated. The obtained aerogels are light-weight (30-40 mg/cm^3), highly porous, hydrophobic (water contact angle of 135°), and flame-retardant. The as-fabricated aerogels with a thickness of 2 cm exhibit high noise reduction coefficiency (NRC) of 0.36 which is higher than the pineapple leaf-based aerogels crosslinked by polyvinyl alcohol (NRC of 0.32, same thickness). The utilization of pineapple leaves and a sustainable approach without consuming toxic ingredients have created building-graded aerogels derived from biomass for acoustic insulation.

Keywords: pineapple leaves, waterproof, flame-retardant, cellulose aerogels, acoustic insulation.

High-Strength Geopolymer Mortar Using Slag Activated with Silica-Fume

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Abstract. The reaction between alumino-silicate compounds and alkali solution creates a geopolymer with a good binding property. In recent decades, much research on geopolymer materials has approved their good mechanical and durability properties. Therefore, geopolymer was expected as a replacement for cement production which became responsible for polluting the atmosphere with the emission of greenhouse gases. This study tested experiments on high-strength geopolymer mortar using ground granulated blast furnace slag (GGBFS) as the main alumino-silicate resource and silica-fume (SF) added as 0%, 5%, 10%, and 15% of the total binder under various curing conditions. Two types of sand (0.14mm - 0.315 mm and 0.315 mm - 0.63 mm) were used as aggregate to produce mortar for testing the workability and the compressive strength of geopolymer mortar. The results showed that samples using sand with a size of 0.315 mm - 0.63 mm and 5% silica fume under oven curing samples give higher workability and compressive strength.

Keywords: geopolymer, high-strength, workability, and compressive strength.

Influence of Glass Fibers on the Mechanical Properties and Impact Resistance of Slag Based Geopolymer Mortar

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Abstract. With excellent technical properties and a great reduction in carbon emissions (compared to Portland cement) as well as utilizing fly ash and slag waste, geopolymer is becoming more and more popular. However, the brittle characteristics of geopolymer material are easy to damage under the impact (especially impacts from heavy objects and loads), making concrete lose its ability to work. Therefore, this material must be reinforced by adding fibers to increase the impact resistance. This paper studied the influence of glass fiber on the mobility, compressive and splitting tensile strengths, and impact resistance (through drop hammer test) of geopolymer mortar prepared with ground granulated blast-furnace slag (GGBFS) and fly ash as binders. In addition to the effect on general properties such as reduced dynamic strength, reduced compressive strength, and increased splitting tensile strength with increasing fiber content, samples using long fibers gain higher workability, splitting tensile strength, compressive strength, and impact resistance than samples using short fibers with the same content. Besides, this study showed that slag can be activated on geopolymer materials without heat curing.

Keywords: geopolymer, slag, workability, compressive strength, impact resistance.

Internal Curing Effect of Porous Ceramic Roof Tile Waste Fine Aggregate on Surface Quality of Steam-cured Fly Ash Concrete

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Abstract. Steam curing, one of the methods to enhance the early-age strength of concrete, has a high possibility of deterioration of surface layer quality which strongly influences mass transfer resistance. On the other hand, it is reported that steam-cured fly ash concrete performance could be improved by using porous ceramic roof tile waste coarse aggregate as an internal curing material. However, there are few reports on the internal curing effect of the roof tile waste fine aggregate. Therefore, this study aims to clarify the internal curing effect of porous ceramic roof tile waste fine aggregate on surface layer quality in terms of surface air-permeability, surface moisture content, and pore size distribution. Furthermore, the relationship between the durability and the surface quality was investigated by conducting accelerated carbonation tests. The results showed that the steam-cured fly ash concrete with porous ceramic roof tile waste fine aggregate had a denser pore structure in the surface layer, lower air-permeability at the age of 365 days, and higher carbonation resistance than that without internal curing. It may indicate the internal curing is effective in improving the surface quality of steam-cured fly ash concrete at long ages.

Keywords: steam-cured fly ash concrete, internal curing, porous ceramic roof tile waste aggregate, air-permeability, pore structure.

Investigation of the Effect of Ground Granulated Blast Furnace Slag (GGBS) Content on the Properties of Lightweight Geopolymer Concrete

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Abstract. In this current research, the influences of local ground granulated blast furnace slag (GGBS) content on the properties of lightweight geopolymer concrete were illustrated. The lightweight geopolymer concrete was produced by mixing a geopolymer binder with fine aggregate and keramzite as coarse aggregate. Six ratios of fly ash and GGBS (100-0%; 80-20%; 60-40%; 40-60%; 20-80% and 0-100% by weight) were employed to manufacture the geopolymer binder. In this study, the sodium silicate solution is only used as an alkaline liquid. The properties of lightweight geopolymer concrete were evaluated by using compression test, indirect tension test and flexural test. The experimental results indicate that the highest compressive strength of lightweight geopolymer concrete is 41.73 MPa with 100% GGBS content. The indirect tensile strength is about 0.45-4.67 MPa. The flexural strength of this kind of geopolymer concrete ranges from 0.88 MPa to 4.63 MPa.

Keywords: lightweight, geopolymer concrete, fly ash, GGBS, keramzite.

Investigation of the Flexural Strength of Steel Fiber Reinforced Geopolymer Concrete using Machine Learning Techniques

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Abstract. Geopolymer composites have been studied and applied in many construction fields because of good performance in mechanical properties, workability as well as durability after long using time. The development of artificial intelligence proposes some methods which can predict and determine efficiently the performance of concrete structures through experimental data. The prediction and validation of the performance of fiber reinforced geopolymer composites by machine learning is evaluated in this research. The proposed models use artificial neural network ANN, deep neural network DNN, and 245 experimental datasets with 9 input variables. The validation of machine learning approaches shows the effectiveness of predictive methods with 90%, and 85% in ANN, and DNN respectively. The proposed models can be applied for designing the standard mix for steel fiber reinforced geopolymer concrete.

Keywords: steel fiber, geopolymer concrete, artificial neural network, deep neural network, flexural strength.

Investigation of the Permeability of Concrete by Penetration Method and Numerical Analysis

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Abstract. The study of water penetration in concrete has the critical purpose of controlling the erosion process of construction structures that are frequently exposed to wet environments. The study focuses on the permeability of concrete with different grades, combining the use of mineral and liquid waterproofing admixtures to evaluate their effectiveness. The permeability coefficient of concrete is determined based on experimental results by penetration method and numerical analysis. Penetration tests were conducted to determine the permeability of concrete with designed strength from 20 to 40 MPa. Mineral and liquid waterproofing admixtures to improve the density of concrete are used in appropriate concentrations. The three-dimensional (3D) model with finite element analysis in PLAXIS 3D was established to simulate seepage through the air voids in concrete. Testing to determine the permeability of concrete types combined with different kinds of waterproofing admixtures gives reliable results. The simulation model of the process of water penetration in concrete gives consistent results and corresponds to the experimental results.

Keywords: permeability, water penetration, simulation model, waterproofing admixtures, strength.

Laboratory Investigation on Mixing Methods for Polymer Modified Asphalt Mixture

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Abstract. In Vietnam, better pavement materials were used in order to adapt to the high traffic volumes, the heavy truck loading, the hot temperature, and so on. One of them is the application of polymers in modified asphalt or asphalt mixture. When using polymers in asphalt concrete, there are many significant problems such as mixing procedures or mixing methods. Two main types of mixing methods which are conventional dry and wet methods are often conducted around the world. For Polyethylene Terephthalate, the dry method is usually used for its advantage. The properties of asphalt mixture using Polyethylene Terephthalate by application of traditional dry and modified dry methods are investigated through laboratory tests such as Marshall stability, indirect tensile, and static resilient modulus. On the other hand, many percent of Polyethylene terephthalate were added to the asphalt mixture for comparisons.

Keywords: polyethylene terephthalate, marshall stability, indirect tensile strength, resilient modulus, dry method.

Mechanical Property Enhancement of Cemented Soil Using Agricultural By-Product

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Abstract. Soil excavated from construction sites is currently one of the environmental issues. This type of soil, characterized by its weak properties and low strength, is typically disposed of as solid waste. Therefore, it is necessary to improve the characteristics of excavated soil to enable its reuse. In this study, the fiber-cement-stabilized soil method is employed to recycle the excavated soil, and corn husk fiber is used as a fiber material. Unconfined compression and shear box tests are conducted to investigate the influence of corn husk fiber on the behavior of cemented soil. The experiments utilize corn husk fiber with lengths of 30 and 10 mm, and additive amounts of 0, 4, 8, and 16 kg/m^3, along with cement quantities of 16 and 32 kg/m^3. The results indicate that corn husk significantly enhances the characteristics of cemented soil. The highest compressive strength increases are 24.2% and 30.4% when adding 10 and 30-mm fiber, respectively. In terms of the shear box test, residual stress is improved with an increase in the quantity and length of corn husk. Additionally, adding corn husk to cemented soil contributes to the improvement of shear strength and cohesion.

Keywords: soi improvement, fiber-cement stabilized soil, corn hulk, compressive strength.

Mechanical Strengths of High-Strength Concrete Containing Waste Sludge from Thu Duc Water Supply Plant

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Abstract. An enormous amount of waste sludge is released from Thu Duc water supply plant every year, resulting in occupying a land area in the plant and causing air pollution. Therefore, the present study focuses on investigating mechanical strengths of high-strength concrete using such sludge as a partial replacement of Portland cement to eliminate CO_2 emission from a cement production as well as to utilize such sludge towards environmental protection. Four replacement ratios of Portland cement by waste sludge were 0, 10, 20, and 30% by mass of cementitious materials. Mechanical strengths of high-strength concrete with a low water-to-cementitious materials ratio of 0.38 included compressive strength and flexural strength of hardened concrete up to an age of 56 days in addition to slump of fresh concrete. The experimental results showed that as the sludge replacement increased from 0 to 30%, the slump of fresh concrete decreased by 14.3–57.1%, and the compressive strength and flexural strength of hardened concrete decreased by 12.9–40.1% and 11.9–46.2%, respectively. The compressive strength corresponding to an age of 28 days of hardened concrete with 10% waste sludge replacement reached 64.9 MPa, satisfying a strength requirement prescribed in TCVN 10306:2014. In conclusion, the waste sludge from Thu Duc water supply plant could be used as a partial replacement of Portland cement in the production of high-strength concrete towards sustainable development in the construction industry.

Keywords: compressive strength, flexural strength, high-strength concrete, waste sludge, water supply plant

Novel Composite Aerogels Fabricated from Coconut Peat and Chitosan for Heat Insulation

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Abstract. The global need for sustainable and environmentally friendly products made from natural resources has paved the way for significant study into the possible applications of advanced materials, especially bio-based aerogels. To maximize the use of agricultural waste, abundant coconut peat is turned into nanocellulose (average size of 200-400 nm) by sequential alkali pretreatment and ball milling before aerogel fabrication. In this study, chitosan is utilized as an effective crosslinking agent to connect the coconut peat-based nanocellulose by direct blending them and cost-effective freeze-drying for the formation of super-porous unified aerogels. The obtained aerogels exhibit ultra-low density (below 16.5 $mg.cm^{-3}$), high porosity (above 98.8%), and high specific surface area (149.0 $m^2.g^{-1}$). Additionally, the as-fabricated aerogels have extremely low thermal conductivity (36.3 $mW.m^{-1}.K^{-1}$) that is much lower than coconut coir aerogels (40-41 $mW.m^{-1}.K^{-1}$) in the previous work and comparable to commercial heat insulation products such as glass wool (31-43 $mW.m^{-1}.K^{-1}$) and cellular glass (38-43 $mW.m^{-1}.K^{-1}$). The effects of chitosan molecular weight and chitosan content (20-80 wt.% of nanocellulose) on the morphology, density, porosity, and thermal conductivity of the synthesized aerogels are comprehensively investigated. It is demonstrated that the higher the molecular weight of chitosan, the better the heat stability, and the heat conductivity can be reduced by adding more chitosan. With ultra-lightweight features and thermal resistance, our aerogels derived from coconut peat-based nanocellulose crosslinked by chitosan are considered promising candidates for heat insulation in practice.

Keywords: nanocellulose aerogel, coconut peat, chitosan, thermal insulation.

Performance of Ultra-High Volume Fly Ash Cement Pastes with Silica Fume Addition

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Abstract. The utilization of silica fume (SF) construction materials is currently regarded as one of the solutions to achieve not only better material properties but also environmental benefits. In this study, different proportions of SF were used to modify the performance of ultra-high-volume fly ash cement pastes (UHVFP). The effects of SF contents on the porosity, drying shrinkage, compressive strength, water absorption, and chloride ion penetration of UHVFP prepared with a water-to-binder ratio of 0.3 were investigated until 120 days. The results showed that the higher SF content (up to 15%) significantly contributed to the reduction of porosity and limitation of the drying shrinkage of UHVFP samples. It was also found that the later compressive strength of UHVFP containing SF was continuously improved with increasing the SF dosage compared to that of the UHVFP without SF inclusion. Besides, both water absorption and chloride ion penetration of the UHVFP incorporating SF were enhanced up to 120 days in comparison with the control samples.

Keywords: silica fume, porosity, compressive strength, water absorption, chloride ion penetration, drying shrinkage.

Pore Network Modeling to Predict CO_2 Injection Efficiency

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Abstract. According to previous research results that carbon dioxide (CO_2) emitted through various industrial activities causes global warming, interest in carbon dioxide storage is increasing. Carbon capture and storage (CCS) in the ground requires geotechnical understanding, such as rock stability and fluid flow in porous media. The injection efficiency of CO_2 varies depending on the CO_2 state, the type and concentration of additives, and the pore geometry. In this study, we developed a pore network model to predict CO_2 injection efficiency. Additionally, we validated the pore network model compared with the micromodel injection test with a similar condition. Based on the developed pore network model, a sensitivity analysis of CO_2 injection efficiency is conducted concerning the above factors. As a result of the analysis, the injection efficiency increased due to the interfacial tension and surface contact angle characteristics of the additive, which led to a decrease in capillary pressure. Furthermore, the injection efficiency increased with the poor-graded distribution, and the injection efficiency decreased with the well-graded distribution owing to the percolation effect. A pore network developed in this study is anticipated to predict the efficiency of CO_2 injection based on the ground conditions.

Keywords: pore network modeling, interfacial tension, contact angle, capillary pressure, injection efficiency.

Strength Development Characteristics of Concrete Using Coal Gasification Slag Fine Aggregate

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Abstract. Coal gasification slag (CGS) fine aggregate is a byproduct of integrated coal gasification combined cycle (IGCC) power plants. In Japan, the Japanese Industrial Standard JIS A 5011-5:2020 "Slag aggregate for concrete - Part 5: Coal gasification slag aggregate" was established in 2020, and the use of CGS as a concrete aggregate was considered. This study investigated the strength properties of concrete in the standard strength range (approximately 20–40 N/mm^2) and high-strength concrete with a water-to-cement ratio of 25% and 30% when CGS was used as a fine aggregate. In the case of CGS concrete, the amount of additional admixture to obtain the same workability could be less than that of the natural sand concrete. CGS concrete of 20–40 N/mm^2 strength exhibited a lower initial strength and higher long-term strength than did the natural sand aggregate. Moreover, the high-strength concrete was found to have lower strength than natural sand concrete for the same water-to-cement ratio, and Young's modulus was higher than that of the natural sand concrete, regardless of the strength properties.

Keywords: coal gasification slag fine aggregate, high-strength concrete, compressive strength, young's modulus

Study of Hybrid Steel Fibers Reinforcement Effects on the Compression Properties of Non-Proprietary UHPC

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Abstract. Non-proprietary ultra-high-performance concrete (UHPC) is renowned for excellent mechanical properties, especially high compressive strength which is generally above 150MPa. Despite the high compressive strength, the failure mode of non-proprietary UHPC under axial loading is sudden, brittle, and explosive. The undesired compression failure mode is not ideal for structure design and undermines the engineering value of non-proprietary UHPC. This research targets to convert the compression failure mode of non-proprietary UHPC from brittle to ductile with hybrid steel fiber reinforcement and select the most effective reinforcing proportion. In this research, a ground granulated blast-furnace slag (GGBS) based non-proprietary UHPC mix is reinforced with five combinations of two steel fiber types with straight ends. The lengths of the two steel fibers are 6.5 mm and 13 mm, respectively. The total volume fraction of steel fibers is 2%. The 28-day compressive strengths and the failure modes of the reinforced samples are compared to select a hybrid steel fiber combination that transforms the failure mode type of non-proprietary UHPC and strengthens the compression performance most effectively. The experiment results demonstrate that: (1) with steel fibers presented, non-proprietary UHPC is capable of continuously taking compressive load after paste cracks; (2) instead of explosive brittle failure mode, fiber reinforced non-proprietary UHPC fails in a ductile behavior under axial compression load and the samples stay in integrity; (3) hybrid steel fiber reinforcement is more effective than single type steel fiber reinforcement in improving the compression performance of non-proprietary UHPC.

Keywords: non-proprietary UHPC, steel fiber reinforcement, hybrid steel fiber, compressive strength, ductile concrete.

Study on Properties of Unfired Brick Fabricated from Fly-ash and Bottom-ash from a Thermal Power Plant

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Abstract. The advantages of using waste sources from thermal power plants to produce unfired bricks bring the dual effect of not losing the wasteland area, solving the problem of environmental pollution, and creating a source of raw materials for production. Fly ash and bottom ash from a thermal power plant are used in the production of unfired bricks in this study. These two raw were used to substitute cement and crush stone, respectively at several contents in brick mix proportion. The properties of unfired brick were evaluated according to the results of physical tests along with compression, bending, abrasion, adhesion, and pull-out tests. The test results of bottom ash and fly ash showed the quality and applicability based on physical and chemical properties. Testing on bricks corresponding to different grades shows that the properties of bricks have a clear classification.

Keywords: unfired brick, fly ash, bottom ash, abrasion test, adhesion test, pull-out test.

Study on Reaction between Fly Ash and Slag Cured at Different Ambient Temperature in Geopolymer Concrete

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Abstract. Geopolymer concrete is known as a relatively new material in terms of replacement in cementious concrete and applied as a construction material. In this research, the factors affecting the fresh and hardened properties of ambient cured fly ash and slag, which are waste materials from thermal power plant, on geopolymer concrete. The fly ash in some power plants are used as alumino-silicate resource in geopolymerization. On the other hand, slag is used as aggregate in mix porportion of concrete. The ratio between alkaline liquid and fly ash is also varied in mix proportion. The results are indicated that fly ash is reacted with slag and alkaline liquid with diffirent ambient temperature. The fresh properties of geopolymer concrete can be improved with an increasing in ratio of alkaline liquid and fly ash. Hence, the compressive strength of concrete also improved with diffirent amount of fly ash and cured at higher ambient temperature and suitable liquid content.

Keywords: fly ash, slag, ambient temperature, fresh concrete, strength, geopolymer concrete.

Study on Strength and Durability of Fiber-Cement-Stabilized Soil Using Waste Gypsum Board Paper

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Abstract. A new recycling method for high water content sludge called "Fiber-cement-stabilized soil" has been developed. In this method, paper debris (fragments of old newspaper) and cement are mixed with the sludge. The improved soil produced by this method has several features. However, recently, the price of paper debris is increasing, and the recycling cost is increasing. Therefore, waste gypsum board paper as a substitute for paper debris is focused on because most of the waste gypsum board paper is disposed in the final disposal site, they can be obtained at an extremely low cost. In this study, the strength characteristics of improved soil using waste gypsum board paper were investigated from the results of the unconfined compression test. From the results, the waste gypsum board paper can be used as a substitute for paper debris although a considerably larger amount of board paper had to be added to achieve the same failure strength as that of the fiber-cement-stabilized soil. In addition, it is possible that the additive amount of board paper can be determined by the results of the bleeding test after 96 hours.

Keywords: fiber-cement-stabilized soil, waste gypsum board paper, failure strength, recycling, ground materials

Ultra-High Volume Fly Ash Cement Pastes Modified with Industrial Hydrated Lime

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Abstract. Developing renewable materials has emerged as a global priority to fulfill the rising need for green building materials. The proposed research aims to develop ultra-high volume fly ash cement pastes (UHVFP) modified with industrial hydrated lime (HL), which incorporates a massive amount of fly ash to substitute conventional cement for environmentally friendly purposes. The porosity, drying shrinkage, compressive strength, and chloride ion penetration tests were conducted on UHVFP samples containing different HL contents (0, 5, 10, 15, 20, and 25%). Overall, the test results suggest that the addition of 5–15% HL enhanced the compressive strength of UHVFP samples throughout all stages of curing. At 120 days, the UHVFP samples with 15% HL possessed the highest compressive strength of 49.7 MPa, whereas this value of the 25% HL sample achieved the lowest bearing capacity of 24.1 MPa. This finding was in good agreement with the porosity and drying shrinkage results since desired engineering properties can be obtained by controlling the HL usage of less than 15%. By using an appropriate HL content (5–15%), the ion charge transmitted through the UHVFP combination can be minimized, resulting in a 40% increase in resistance over the reference mixture. The test results confirmed that the porosity and the ion charge values are strongly correlated since a lower porosity value can prevent chloride ions from diffusing through the mixture accompanied by a denser structure. Thus, the 15% HL was found as an optimum content in UHVFP to achieve maximum performance and promote sustainable development purposes.

Keywords: ultra-high volume fly ash, cement paste, industrial hydrated lime, chloride ion penetration, sustainable construction materials.

Variation of the Adhesion between Concrete Printed Layers in A 3D Concrete Printed Structure

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Abstract. 3D printing is an advanced technology that is being researched and applied in the construction sector. 3D concrete printing is a technique of generating concrete structures by applying each layer of printing concrete through the control of a robot, hence reducing the amount of human participation in the production process. The adhesion between neighboring layers is one of the indicators used to assess the quality of 3D-printed concrete. Nonetheless, adhesion between printing layers frequently varies with the height of the print concrete structures. Experiments were conducted on 3D-printed concrete blocks with a 500mm height and 10x20mm (height and width) layer dimensions, using the concrete mixture with a water-to-binder ratio of 0.32. The adhesion strength between printed layers was measured using a splitting tensile according to TCVN 8862:2011 on 7- and 28-day-old 3D-printed concrete samples. According to experimental findings, the bonding between the layers of 3D-printed concrete reduces as the height of the printed concrete block increases.

Keywords: adhesion, bonding between layers, printed 3D concrete.

Geotechnical Session

A Lumped-Parameter Model for Soil-Pile-Foundation Systems Undergoing Horizontal-Rotational Motions based on Multiobjective Optimization

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Abstract. Recently, soil-pile-structure interaction (SPSI) has played a vital role in analyzing the dynamic response of shear buildings in soft soil strata and seismically prone zones and assessing the vibration control of high-tech industrial structures with sensitive equipment. This study develops a generic lumped parameter (LP) model for three-dimensional (3D) simplified modeling of soil media and pile groups considering coupled horizontal and rocking motions. A multiobjective jellyfish search (MOJS) algorithm has been widely demonstrated as an efficient and effective algorithm for multiple objective problems; hence, it is adopted to determine the optimal parameters of the proposed LP model. In light of simplicity, soil strata and embedded piles are idealized by the proposed LP model at the pile head, and then the dynamic responses of the 3D soil-pile foundation (SPF) systems to externally forced loadings and seismic motions are easily obtained more straightforwardly with less computational effort. The proposed LP models are easily employed and incorporated into any structural FE programs to compute the time-history response of the SPF systems. The computed frequency-response curves and time-history responses of the SPF system simulated by the proposed model perfectly fit with the complete SPF systems modeled in a specialized SPSI code for forced excitations and ground vibrations. Overall, the proposed LP model offers a straightforward approach yet produces an excellent result in analyzing the dynamic behavior of SPF systems to account for the SPSI effects. Assessing the dynamic response of SPSI systems effectively, it contributes to reducing serious injury and damage after earthquakes, as well as increasing the life-cycle of civil structures and high-tech industry systems.

Keywords: soil-pile-structure interaction, foundation vibration, transient analysis, multiobjective optimization, Jellyfish search.

A Numerical Study on the Frictional Resistance Adjacent the Pile Tip in Clayey Sand Soil

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Abstract. Pile foundations are a commonly used option for constructing buildings, bridges, embankments, and other structures. However, there are several methods available for determining the load-carrying capacity of piles, such as Meyerhof's method, Terzaghi, Peck and Mesri (1996), and the Japanese Institute of Architecture. These methods provide predictions of pile load-capacity but may differ from the results of the pile static test conducted in the field. However, the calculation methods for determining the bearing capacity of piles take into account the frictional resistance that occurs along the entire length of the pile. However, the frictional resistance along the pile body is affected by the displacement of the pile as it slides into the soil, and the displacement of the soil around the pile tip also affects the frictional resistance near the pile tip. Using numerical methods (specifically Plaxis 3D), the research team simulated and investigated the displacement of soil around pile tips of varying diameters in sandy soil located in Ho Chi Minh City. This study revealed that the frictional resistance near the pile tip decreased at a position equal to 0.865 times the pile diameter.

Keywords: pile foundation, pile load-capacity, finite element, plaxis.

A Study of The Behavior of Precast-Concrete-Component Embankment on the Soft Ground

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Abstract. Embankments made of precast concrete components are now widely applied in Ho Chi Minh City and surrounding areas to protect the riverbank with the advantage of shortening the construction time and stages, reducing the construction load. Hollow reinforced concrete block embankment is one of the precast-concrete-component embankments constructed in Ho Chi Minh City. More specifically, in Palm Marina area, Long Truong Ward, District 9, Ho Chi Minh City, the construction of this type of embankment on the pre-stressed reinforced concrete pile foundation started in 2020. However, some embankment sections were eroded in January 2022 during the leveling phase, the main bearing piles are displaced, causing the assembled reinforced concrete block to subside and deviate from the embankment route. The study focuses on the PLAXIS 3D model of this embankment structure on the soft ground of the area to analyze the behavior of the embankment. It is realized that the project area is located in the soft ground with a maximum thickness of silt layer of 18m. However, the existing pile option does not guarantee the bearing capacity of the embankment, leading to instability of its system. Increasing cross-section and number of rows of piles is proposed in this study to enhance the stiffness and ensure the stability of the embankment.

Keywords: embankment, precast concrete components, instability, soft ground, PLAXIS 3D

A Study on Clay-Based Fluid for Shallow Well Drilling

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Abstract. Drilling fluid is essential to the drilling operation to clean the hole, stabilize the wellbore, and reduce friction. Clay-based fluid is commonly used in drilling petroleum wells, bored piles, and water wells. Its characteristic includes rheology and filtration, which strongly affect the drilling process and afterward operation. This study aims to investigate the effect of clay addition on the rheological and filtration loss property of drilling fluid. The bentonite powder was added to tap water with various concentrations of 1 to 5% by weight and stirred using a high-speed stirrer in the laboratory. The rheology behavior of fluids was characterized by using an 8-speed rotational viscometer. The clay-based fluids were then analyzed for filtration loss properties following the American Petroleum Institute (API) test method. The addition of clay material resulted in improved apparent viscosity (AV), plastic viscosity (PV), yield point (YP), and gel strength (GS). In addition, the increased bentonite reduced the volume of fluid loss by maintaining a thicker filtration cake.

Keywords: clay-based fluid, drilling fluid, bentonite, rheology behaviour, filtration loss.

Analysis of a Deep Excavation adjacent to Metro Tunnel Line of Ho Chi Minh City

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Abstract. The back analysis is carried out to investigate and assess the deep excavation by Plaxis 3D software and actual Nexus project monitoring data that includes Metro Tunnel system line No.1 (Metro Tunnel) deformation as well as horizontal diaphragm wall displacement (normal diaphragm wall (DW) and buttress wall (BW)). The validity of the 3D Plaxis finite element, as well as a preliminary assessment of the acceptability of E_{50}^{ref} according to undrained shear resistance (S_u) in the case of cohesion soil and E_{50}^{ref} according to SPT value in the case of cohesionless soil, combined with subdividing a thick sand layer into many elemental layers. Additionally, the stiffness of the Metro Tunnel in the cross-sectional and longitudinal directions are different, making the tunnel's two-direction behavior anisotropically. It has recommended a reasonable stiffness ratio (E_1/E_2) for these two modules based on the back analysis value, which is pretty comparable to Metro tunnel system monitoring data. In this study. Moreover, the buttress wall effectively reduces the deformation as compared to the diaphragm wall.

Keywords: deep excavation, tunnel, buttress wall, stiffness effective ratio, back analysis.

Application of Artificial Intelligence to Cluster Soil Behaviour from CPTu Data

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Abstract. In this study, the authors used many artificial intelligence algorithms to cluster soil behaviour from CPTu data, that includes cone resistance (qc), frictional resistance (fs), dynamic pore pressure (u2), corrected cone resistance (qt) and friction ratio (Rf). The soil behavior type is following Robertson (1986). There are four model are built in this study include: i. Supervised learning with SVM algorithm by qc, fs, u2, qt and Rf; ii. Supervised learning with SVM algorithm by qt and Rf; iii. Unsupervised learning with Kmeans algorithm by qt and Rf with three clusters; and Unsupervised learning with Kmeans algorithm by qt and Rf with nine clusters. To satisfy "Imbalanced data" and Roberson's chart shape, the raw data are being preprocessing within two steps before clustering with KMeans or continue to divide to 3 minor set for SVM algorithm that includes: training set – 50%, validation set – 20% and test set – rest. The result indicated the Supervised learning with SVM algorithm by qc, fs, u2, qt and Rf is the best model, while unsupervised learning with KMeans does not meet the requirements.

Keywords: CPTu, soil classification, AI, SVM, KMeans.

Assessment of Safety Factor of River Roof with Considering a Variation of Input Parameters as Bulk Unit Weight, Cohesion, Friction Angle and Water Level

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Abstract. The rapidly growing development of the Mekong Delta leads to the needs of infrastructure as well as road constructions for trading. The roads are mainly built along rivers and canals. However, riverbank erosion in the Mekong Delta caused by geological characteristics, hydrological characteristics and so on is becoming more and more complicated. Therefore, in this paper, the authors analyze the influence of changes of geological parameters such as bulk unit weight, cohesion, friction angle of the soil as well as water level on safety factor (FS) of the roads in Vinh Long City, Vinh Long Province. The variation of geological parameters is analyzed statistically from 15 constructions in Vinh Long City. Several statistical parameters such as mean, variance and standard deviation are used as input parameters, and then Monte Carlo simulation in GEOSTUDIO software is used to compute the failure probability of the roads. By using a combination of SIGMA/W, SEEP/W and SLOPE/W modules in GEOSTUDIO software, the paper comprehensively evaluates all factors affecting the safety factor of a riverside route. The results show that using only one parameter to design and calculate has a lot of potential risks. In fact, sliding failure has occurred at a few locations along the entire route although they have been reinforced with wooden piles. The computed results show that there is still a probability of 21.1% of landslide (FS<1) in the research area while FS calculated by using a set of average parameters gives a value greater than 1.2.

Keywords: factor of safety (FS), Monte Carlo simulation (MCS), GEOSTUDIO, bulk unit weight, cohesion, friction angle, water level.

Behavior of Isotropic ($I_2=I_1$) and Anisotropic ($I_2 \neq I_1$) Diaphragm Walls in Finite Element Analysis Model of Deep Excavation

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Abstract. The diaphragm wall of the deep excavation pit is the Barrette piles connected, standing side by side in a row to create a diaphragm wall system, so that the flexural stiffness of the diaphragm wall in the vertical and the horizontal direction is different. That is, the horizontal stiffness (axis 2) will be less than the vertical stiffness (axis 1) E2I2 << E1I1 . In this study, the author analyzes and simulates the Barrette pile diaphragm wall system working according to the 3D model of the Song-San excavation project located at the K1 area of the Taipei basin, Taiwan. The results are checked and compared with the actual measurement results. Through the process of analyzing and observing the obtained results, the author draws a few conclusions as follows: Firstly, the influence of the corner effect and the stiffness of the diaphragm wall in the horizontal direction is realistic and needs to be considered. In consideration, it is necessary to simulate the deep excavation according to the 3D model to analyze and properly evaluate this problem. Secondly, the simulation of the deep excavation according to the 2D model only properly evaluates the behavior of the diaphragm wall in the middle of the long edge segment (L) of the excavation, on the middle L/2 segment and when considering the behavior of the diaphragm wall on the L/4 segment from corner of the diaphragm wall, it should be considered on the 3D model. Third, in order to quickly model and save time for discrete analysis of many elements, in preliminary calculations, it is possible to accept the diaphragm wall simulation as a continuous wall (W-IP) combined with correction the stiffness of the diaphragm wall in the horizontal direction through the ratio n = I2/I1 = 0.76.

Keywords: diaphragm wall, deep excavation, barrette pile, simulation, finite element, plaxis.

Comparison of Shear Strength of Cohesionless Soil in Direct Shear and Simple Shear Tests under Repeated Loadings

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Abstract. Designing the stability of pavements or embankments is a challenging issue in a geotechnical engineering sector. Many studies have been carried out to investigate the shear strength of cohesionless soil under monotonic direct shear (DS) and simple shear (SS) tests. However, few studies have evaluated the influence of repeated loadings on the strength of soil. The goal of this study is to evaluate the strength characteristics of glass bead samples using repeated DS and SS tests. The same testing procedures were applied for all samples in two tests. Samples were tested under drained strain-controlled mode for each normal stress (σ_n) of 50, 100, and 150 kPa under shearing rate of 0.1 mm/min. The experimental results show that the peak shear strength in DS gave generally higher than that in the SS. The shear stress ratios between two tests (τ_{SS}/τ_{DS}) ranged within 0.95±0.10. The friction angles in DS were in a wide range of 25.7^0~28.7^0, while those obtained in SS were a narrow range of 26.6^0~26.8^0.

Keywords: cohesionless soil, direct shear, repeated loading, simple shear, shear strength.

Consolidation Behavior of A Soft Ground Improved by Vacuum Preloading Method at Ca Mau Electric Power Plant, Viet Nam

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Abstract. Vacuum preloading method was invented long time ago. However, this method has not been widely applied in Vietnam. This paper presents the improvement work by vacuum preloading method at Ca Mau electric power plant, Viet Nam. The project is located at the Mekong Delta, which is well-known by the thick layer of soft clay. The finite element method has been applied to analyze the vacuum induced consolidation process. The comparison between predicted results and monitored results showed a little difference between these two results. Based on the monitored settlements and pore water pressures, the back analysis showed the considerable difference between the real value and design value of the coefficient of horizontal consolidation. The further analysis of settlement showed the ability of reducing preloading time by vacuum pumping as compared with fill preloading method. From the studied results, the conclusions and the proposals are presented for the improvements at Ca Mau electric power plant, Viet Nam.

Keywords: vacuum preloading, soft soil, consolidation, finite element method.

Couple Effect of Loading Frequency and Uniformity Coefficient on the Liquefaction Resistance of Sand

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Abstract. The uniformity coefficient (C_u) of sand and the cyclic loading frequency (f) play an unclear role in affecting the cyclic undrained behavior of soil. This note presents experimental research on the combined effect of f and C_u on the liquefaction resistance of sand. A series of constant-volume, stress-controlled, cyclic direct simple shear tests (CDSS) were performed on silica sands mixed with different particle proportions to make both poorly (SP) and well-graded (SW) samples. Both SP and SW samples are deposited in a dry state with medium density, consolidated to vertical stress of 100kPa and cyclically loaded under cyclic stress ratio of 0.1 with a wide range of f (f=0.03, 0.05, 0.1, 0.2, and 0.5 Hz). In SP sand, number of cycles to cause liquefaction remains unchanged when load frequency rises from 0.03Hz to 0.1Hz, and increases when load frequency rises from 0.1Hz to 0.5Hz. It can be stated that SP sand's liquefaction resistance is affected by the high loading frequency. On the contrary, the effect of f on the liquefaction resistance of SW sand is negligible. Furthermore, SP sand is more resistant to liquefaction than SW sand. According to this study, both Cu and f should be included in the analysis of sand's liquefaction resistance.

Keywords: liquefaction resistance, loading frequency, uniformity coefficient, poorly graded sand, well-graded sand.

Deformation Characteristics of Saturated Soft Clay in Ho Chi Minh City and Mekong Delta

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Abstract. The soil profiles of Ho Chi Minh City and Mekong Delta consist mainly of saturated soft clays, which substantially vary in thickness and physico-mechanical properties. It is, therefore, very crucial to properly identify the characteristics of these clayey soils for reliable estimation of deformation. However, previous studies have focused on the soil properties and their relationships only at a certain pressure range which is not applicable to the soils in those regions. Accordingly, this study analyzed the deformation characteristics of soft clays at their working conditions in Ho Chi Minh City and Mekong Delta, based on the data collected from existing projects and additional performed experiments. The values of deformation modulus and compression index at the end of primary consolidation stage and those at twenty-four hours after loading show no significant differences. Besides, the compression index is closely correlated with the void ratio. Moreover, the soft soil near the ground surface is over-consolidated and the over-consolidation ratio varies nonlinearly with depth. The ratio C_h/C_v varies from 1.6 to 1.8, while the structural strength is negligible, ranging from 1 to 2 kPa.

Keywords: saturated soft clays, deformation characteristics, consolidation, Ho Chi Minh city, Mekong Delta.

Effect of Buttress Walls on Reducing the Wall Displacement for Deep Excavations Adjacent to Metro Tunnels

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Abstract. Buttress wall is a very new construction technique in Vietnam. With a special location, where one side is adjacent to Metro tunnel at a very small distance of approximately 4.2m, NEXUS high-rise building is the first construction in Vietnam that has to utilize this new technology of retaining wall. In this paper, finite element analysis via Plaxis software is used to study the actual basement excavations and obtain the structural displacements. Series of numerical simulations were conducted to evaluate the performance of buttress wall under different loading conditions. Actually, the basement excavation has resulted in a small displacement of the nearby tunnels, which implies that buttress wall indeed has a significant impact and has effectively prevented nearby metro tunnels from displacement. Based on the findings of this study, it is implied that buttress wall can be used as a reliable, sustainable and effective solution for deep excavations in some special civil engineering projects.

Keywords: deep excavation, adjacent tunnel, buttress wall, diaphragm wall, displacement.

Effectiveness of Soilcrete to Reinforce Earth Levees

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Abstract. Soil - cement (soilcrete) columns have high potential to create seepage cutoff walls and to enhance slope stability for earth levees against annual floods in the Mekong delta. This paper evaluated the effectiveness of soilcrete walls to reinforce earth levees. The strength and hydraulic conductivity of several typical soil types taken in the Mekong delta such as soft clay, medium clay, and medium stiff clay mixing with cement at a content of 300 kg/m^3 were determined in the laboratory. Soilcrete walls were designed basing on tested results in the laboratory to reinforce earth levees in Dong Thap and An Giang provinces. Seepage and slope stability of the levees were analyzed using the SEEP/W and SLOPE/W softwares. The results indicate that the soilcrete walls were highly effective in cutting seepage off and increasing stability significantly in case of rapid drawdown of floodwater. A 0.5-m single row soilcrete wall can reinforce successfully for earth levees with less slide situation. A 1-m double row soilcrete wall can reinforce earth levees sustainably.

Keywords: soilcrete, permeability, earth levee, seepage cutoff wall, slope stability.

Evaluate the Effect of Grain Composition and Moisture Content on the Shear Strength of the Sand-Clay Mixture

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Abstract. The shear strength of the soil is one of the crucial parameters in the calculation of geotechnical problems such as slope stability, soil bearing capacity, etc. Investigation of the correlation between the factors affecting the shear strength helps to better understand the properties of the shear strength of the soil. In this study, experiments were conducted to clear up the influence of grain composition and moisture content on the shear strength of the soil. By using a series of direct shear tests on samples prepared with various sand-clay (bentonite) ratios and various moisture content. The results showed that the shear strength decreased when the clay ratio increased from 20% and the moisture content increased from 15%. With clay ratios of less than 20% and moisture content of less than 15%, the shear strength is mostly less affected by grain composition and moisture content.

Keywords: shear strength, direct shear test, grain composition, moisture content.

Evaluation of Tensile Strength of Cement-treated Soil based on Laboratory Tests

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Abstract. Tensile strength and unconfined compressive strength of cement-treated soil are crucial mechanical parameters in soil stabilization by the cement mixing method. Although the unconfined compressive strength of soil-cement mixture has been well-documented, tensile strength has not received much concern. The purpose of this paper is to study the tensile strength of cement-treated soil using Portland Cement Blended PCB 40 and figure out the relationship between these two parameters. Totally, 54 soil-cement mixing specimens were prepared with different cement-soil ratios (i.e., C/S = 10%, 15%, 20%) and stored at room temperature under air-humid condition. The results of laboratory Brazilian tests and unconfined compression tests show that the average ratio of tensile strength and unconfined compressive strength corresponding to the air-humid curing condition is about 0.08. There is not much difference in the ratio of the tensile strength to the unconfined compressive strength regardless of cement : soil ratio with curing time. In addition, the maximum amount of tensile strength is 0.78 MPa, with 20% of cement content after 15 days of curing.

Keywords: cement-treated Soil, unconfined compressive strength, tensile strength, UCS test, Brazilian test.

Evaluation of The Effectiveness of Geosynthetic Encased Granular Column in Soft Soil Improvement by Numerical Method and Field Experiment

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Abstract. The Unit cell model is used to research the effectiveness of geosynthetic encased granular column (GEC) for VIFONE II factory area at LONG AN province, VIET NAM in soft ground improvement. Settlement of ground is determined by applying Plaxis 2D simulation software; from that, computed results by Plaxis 2D is analyzed, compared with the field monitoring results. Research results show that in case of granular column without geosynthetic, as using "Soft soil" model, resulted data by Plaxis are approximately similar to those observed from field monitoring with an error of 8.3% up to 22.8%. As applying geosynthetic encased granular column (GEC) in case of loading less than 100 kPa, the difference of settlement between ground reinforced by granular column and by GEC is not significant, only from 0.2% up to 3.2%. The difference of settlement of ground reinforecd by granular column with and without geosynthetic reduces from 15.1% to 6.8% corresponding to loading from 400 kPa to 800 kPa.

Keywords: Geosynthetic encased granular column (GEC), soft soil model, PLAXIS 2D, settlement.

Parametric Study on Behavior of Soft Ground Reinforced by Stiffened Deep Cement Mixing (SDCM) Columns

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Abstract. A well-researched soft soil improvement method, deep cement mixing (DCM), has been developed into various innovative types of soil mix columns, one of them is the stiffened deep cement mixing (SDCM) column. Numerous full-scale, physical model load tests and numerical models were carried out to study the behavior of soft soils improved by SDCM columns under embankment load. In this paper, numerical models using finite element PLAXIS 3D software are implemented to further investigate the settlement, differential settlement and the load-sharing proportions of foundation system on soft ground reinforced by SDCM columns. Various core pile lengths were inspected, the maximum settlement of the raft foundation could be decreased up to 2.7 times when the length of core pile increased. Furthermore, the load shared by soft ground under the raft decreased 2 times compared to reinforcement with DCM columns only. Besides, the spacing between SDCM columns was also analyzed, a distance of 3 times the column diameter should be applied to minimize the settlement as well as the differential settlement of the raft foundation.

Keywords: SDCM, DCM, soft ground, settlement, percentage of load-share.

Powdered Enzyme from Australian Weed for Bio-Stabilisation

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Abstract. The urease enzyme derived from Paddy melon (Australian weed) seeds, is highly effective in catalyzing the hydrolysis of urea in the presence of calcium ions. This reaction results in the precipitation of calcium carbonate, which then binds/cements soil particles. This process is known as the Enzyme-Induced Carbonate Precipitation method (EICP). Recently, EICP has been utilized in geotechnical engineering to enhance various physical properties of soil, such as strength, hydraulic conductivity, and reactivity. However, crude enzyme solution is easily degraded with time, even at low temperatures, making it challenging to produce and store for larger-scale applications. Therefore, this study aims to transform the liquid enzyme solution into a powdered enzyme using the freeze-drying technique (lyophilization) to avoid degradation problems. The catalytic activity of the enzyme powder from Paddy melon was measured at 2.867 KU/g, which is equivalent to commercially available purified enzymes. In addition, cost analysis suggested that the powderisation process can help produce the enzyme powder at a lower cost than commercial products, enhancing the affordability of the EICP application in soil stabilization.

Keywords: EICP, enzyme powder, freeze drying, soil stabilization.

Predicting Bearing Capacity of Strip Footing on Slope Using A Soft Computing Technique

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Abstract. The paper proposes a new hybrid soft computing technique to predict the bearing capacity of a strip footing on the c, ϕ slope. The finite element analysis based on the Plaxis code is adopted to simulate the strip footing on the c, ϕ slope. The influences of design parameters (i.e., the slope angle, distance from the foundation to the slope, and soil strength) on the bearing capacity are investigated. The obtained FEA results are compared to the previous study. A good agreement between the prediction from FEA results and those of the prior research is received. The FEA results are prepared in the design table for practical design. Based on FEA results, a machine learning approach, Multivariate adaptive regression spline (MARS), is adopted for proposing an empirical equation and considering the impact of each investigated parameter on the bearing capacity. These results can be a good reference for practical engineering in designing strip footing on the c, ϕ slope.

Keywords: bearing capacity, strip footing, slope, MARS.

Prediction of Liquified Soil Settlement Based on Artificial Neural Network

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Abstract. Severe seismic movements caused certain special types of soil, such as loose sands or poorly gravelly soil, to become liquified, which is referred to as soil liquefaction and led to ground settlements. Over the past few decades, laboratory or in-situ testing approaches have mainly been applied to investigate these settlements. The aim of this study was to use an artificial neural network (ANN) to predict ground settlement due to the Pohang earthquake. An ANN algorithm was implemented to the soil dataset for this purpose. Various variables of soil characteristics were considered as input parameters namely unit weight, soil layer depth, standard penetration test blow counts, and cyclic stress ratio. Furthermore, different prediction errors of mean average error (MAE), mean squared error (MSE), root mean squared error (RMSE) and the coefficient of determination or R-squared were employed in this study to evaluate the model performance. The testing results revealed that the difference between the original and predicted values using MAE, MSE, and RMSE was 0.219, 0.099 and 0.314, respectively. Besides, the R-squared value of 0.877 was achieved by predicted results and actual values of ground settlements. It concluded the feasibility of the proposed ANN model with the high R-squared value for predicting liquefaction-induced settlements.

Keywords: artificial neural network, liquefaction, machine learning, settlement.

Random Field Modelling of Soil Shear Strength for Reliability Analysis of Deep Excavation in Sand

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Abstract. Random field model of spatial variability data plays an important role in reliability analysis of geotechnical problems. In this study, random fields of soil shear strength are defined using Cholesky decomposition technique and Monte Carlo simulation. The correlation coefficient between cohesion and friction angle is used to simulate independent and dependent structures of soil shear strength. The reliability analysis of deep excavation in sand utilising random finite element method is conducted. The instability of deep excavation can be identified when the predicted wall movements are higher than the limiting criteria of the movements. In this study, 1,000 realisations are used for Monte Carlo simulation. The results indicate that significant variations of cohesion and friction angle are caused by different correlation coefficients. Failure probability can be defined by the number of instability events divided by the number of realisations. The lateral wall movements and the failure probability increase with an increase of excavation depth. The dependent structure type of random field soil shear strength can underestimate the failure probability of deep excavation in sand. It is noted that independent and dependent structures of random field soil shear strength are important in reliability analysis.

Keywords: random field, shear strength parameters, deep excavation, correlation coefficient.

Response of a Soft Basin to Incident Rayleigh Wave Considering Hysteresis Behavior of Soil

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Abstract. The topography of an area, i.e., the physical features and their arrangement, largely modifies the intensity of earthquake ground motion there. It is widely recognized that a basin can significantly amplify or deamplify motions at the ground surface. Naturally, the response of a soft basin to an incident Rayleigh wave has received much attention in the area of seismic site effects. However, previous studies, using boundary element method and its variants, have to resort to the assumption of linear elastic behavior of soil. This idealized assumption does not reflect the true soil behavior and can lead to an overestimate or an underestimate of the surface ground motion. Accordingly, this study aims to analyze the response of a trapezoidal soft basin to incident Rayleigh wave, considering the hysteresis behavior of soil where shear modulus and damping ratio vary with shear strain. The novel use of time-domain finite element method in simulating the propagation of Rayleigh wave enables the numerical model to incorporate such nonlinear behavior of soil. The obtained ground motions are subsequently compared with those from a simulation using linear elastic behavior of soil. The comparison illustrates the effect of soil hysteresis characteristics on the ground motions at locations inside the basin, in which the shaking level can be noticeably increased or reduced.

Keywords: hysteresis soil, Basin effect, Rayleigh wave, finite element method, ground motion.

Uplift Soil – Pipe Interaction Considering Large Deformation and Post-peak Softening of Dense Sand

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Abstract. Uplift behavior is an important aspect in the analysis of soil – pipe interaction under circumstances of geohazards, such as landslide, liquefaction, faulting, and soil subsidence. Such behavior includes large displacement of pipe, and large deformation and nonlinearity in soil responses. Conventionally, the uplift soil – pipe interaction problem is analyzed by Finite Element Method (FEM), which becomes an error-prone approach when element mesh being distorted in large deformation scenarios. This study aims to analyze such interaction problem for the case of pipe moving upward in dense sand, in which Smoothed Particle Hydrodynamics (SPH) method is used to deal with large deformation of soil. In the soil region with small deformation, FEM is used to reduce the computational time. The post-peak softening behavior of dense sand is represented by the variations of mobilized friction and dilatancy angles depending on plastic shear strain. The hybrid SPH-FEM model of uplift soil – pipe interaction problem is validated with published experimental data. More numerical simulations are subsequently conducted to investigate the uplift resistance, failure mode, and shear band appeared in soil.

Keywords: soil-pipe interaction, smoothed particle hydrodynamics, finite element method, upward movement, dense sand.

Structure Session

A Coupled Cs-Dsg3/Bem Method for Hydroelastic Analysis of Pontoon-Type Vlfs with Arbitrary Plan Shape

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Abstract. A cell-based smoothed discrete shear gap method (CS-DSG3) was proposed for various analyses of Mindlin plates. The CS-DSG3 only uses the three-node triangular elements and can give highly accurate solutions owing to the use of the cell-based strain smoothing technique for the three-node triangular elements, and hence is highly suitable for analyses of any complicated geometries of plates. This paper aims to couple the CS-DSG3 with the Boundary Element Method (BEM) for hydroelastic analysis of pontoon-type Very Large Floating Structures (VLFS) of any plan shape. The VLFS is modelled as a Mindlin plate floating on an ideal fluid in which the linear wave theory is applicable. The structural and fluid domains are discretized using the three-node triangular elements. While the CS-DSG3 is adopted to formulate the structural equation, the BEM is employed for formulating the water equation. The hydroelastic analysis is performed in the frequency domain. The accuracy of the CS-DSG3/BEM method is validated by comparing its results with published solutions. Parametric studies using the proposed method are also carried out for various VLFS shapes to study effects of VLFS shape on the hydroelastic response.

Keywords: cell-based smoothed discrete shear gap method (CS-DSG3), boundary element method (BEM), very large floating structure (VLFS), hydroelastic analysis.

A Quasi-3D Finite Element Model for Free Vibration and Buckling Analysis of Bidirectional Functionally Graded Sandwich Plates with Honeycomb Auxetic Core

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Abstract. This paper develops a finite element model based on a quasi-3D theory to analyse the vibration and stability of bidirectional functionally graded auxetic sandwich (2D-FGASW) plates. The plates consist of three layers, a honeycomb auxetic with negative Poison's ratio and two outer skin layers with material properties that vary in thickness and length directions by power gradation laws. A four-node rectangular element with nine degrees of freedom per node is used to discretize the domain of the plates. The governing equation is established by applying Hamilton's principle. Several comparative examples are made to confirm the accuracy and convergence of the present model. Finally, some new investigations evaluating the influence of material and geometrical parameters on the vibration and buckling responses of the plates were investigated in detail.

Keywords: free vibration, buckling, plates, 2D-FGM, honeycomb auxetic, quasi-3D, FEM.

A Review on Finite Element Analysis of Fibre Reinforced Polymer Reinforced Concrete Beam

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Abstract. A reinforced concrete beam's structural behaviour and performance can be strengthened with fibre reinforced polymer (FRP) composite material. This paper investigates a reinforced concrete beam review using finite element analysis (FEA) software such as ABAQUS and ANSYS to conduct the behaviour of composite beams with FRP. The FEA model provides several mechanical indices, including load-deflection curve, component strain, and fracture propagation. The calculations performed with the effect of interface slip are taken into account and closer to experimental values, demonstrating that FEA model can reliably predict the general mechanical behaviour of composite beams under negative moments. Finally, a parametric analysis of the static behaviour of composite beams strengthened with/without FRP laminates is carried out using FEA model. The bearing capacity of the composite beams is studied concerning factors such as the FRP width, design location, number of layers, ratio of longitudinal reinforcement, and degree of shear connection. As a result of the negative moments applied to composite beams, the load-deflection, stiffness, and bending resistance can be significantly increased using FRP composite material. The bearing capacity is found to be highly dependent on the layout width and layer number of the FRP laminates at a low reinforcement ratio. At the same time, the increase rate becomes insignificant after three layers. The reinforcing ratio significantly affects the composite beams' bearing capacity under negative moments but not under shear connection degree.

Keywords: fibre reinforced polymer; reinforced concrete beam; structural behaviour; finite element analysis; numerical modelling

Analysis of One-Dimensional Hexagonal Quasicrystal Elastic Layer under Surface Loads

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Abstract. This study aims to develop an elastic solution for a two-dimensional, surface-loaded layer made of a one-dimensional (1D) hexagonal quasicrystal (QC) resting on either a rigid or elastic substrate. The governing equations, in terms of the phonon and phason displacements, for both layer and substrate are derived from the linear elasticity theory for 1D-hexagonal QC material and then solved by the method of Fourier transform and direct stiffness technique. An efficient and accurate numerical quadrature is then implemented to evaluate all involved integrals resulting from Fourier transform inversion. After being verified with benchmark cases, the derived solutions are utilized to investigate the influence of the coating thickness and type of substrate on the mechanical behavior of the medium including the coated object and the 1D-hexagonal QC coating layer.

Keywords: 1D-hexagonal QCs; phonon field; phason field; fourier integral transform; surface loaded elastic layer.

Assessment of Axial-Flexual Behavior of Reinforced Concrete Column Wrapped with CFRP Using Probabilistic Machine Learning Model

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Abstract. Using Carbon fiber-reinforced polymer (CFRP) to enhance the capacity of structural reinforced-concrete members is a practical and fast approach that is increasingly recognized among the civil engineering community. However, in order to effectively and economically apply this approach, it is important to reliably estimate the CFRP-strengthened members' performance based on their input parameters, such as member length, cross-section sizes, material properties, and external loadings. Toward this purpose, this study aims to develop a predictive model that can evaluate the axial-flexural behavior of reinforced concrete columns enhanced by CFRP based on, first, extensive columns data collected from literature and experiments realized by the authors. The second key component of the proposed method is the probabilistic machine learning algorithm, namely, quantile regression forest, which can account for the variance of input parameters among different experimental settings and provide the confidence intervals of predictions rather than some predicted values. Such types of results help engineers avoid under/over-estimate the members' performance and produce adequate structural solutions.

Keywords: reinforced concrete; CFRP; probabilistic; machine learning; experimental data.

Buckling Analysis of Porous Functionally Graded Plates in Thermal Environment by Using a Meshfree Method

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Abstract. This study presents the buckling analysis of thermal loaded in thin rectangular plate made of porous functionally graded material. Porous functionally graded materials have material properties vary across the thickness and the porosity, respectively. In this study, Reissner-Mindlin plate theory is implemented for thin plates computation with the help of radial-point interpolation method. The advantage of radial-point interpolation method compared to another methods is the satisfaction of Kronecker delta property that allow to apply directly boundary conditions on field nodes Equilibrium and stability equations, derived through the virtual work principal, are used to determine the pre-buckling temperatures and critical buckling temperatures. Also, the effect of pores distribution on the critical buckling temperature is investigated.

Keywords: porous functionally graded material, buckling analysis, radial point interpolation method, thermal environment.

Classification of Surface Defects on Steel Sheet Images Using DenseNet121 Architecture

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Abstract. Classifying surface defects is vital for steel sheet manufacturers. The conventional approaches have obtained moderate accuracies in terms of classifiers, while these methods have developed by depending on experts or different projects. DenseNet121 model, a machine-vision-based classification approach was proposed to overcome the drawbacks of traditional approaches. The goal of this paper is to apply pre-trained DenseNet121 network for classifying the steel defects categorized as rolled-in scales, patches, crazing, pitted surface, inclusion, and scratches. Fine-tuning transfer learning and k-fold cross-validation were implemented to train and evaluate the performance of the model. Additionally, this study uses Adaptive Moment Estimation (Adam) and Stochastic Gradient Descent (SGD) algorithms to optimize the model parameters. The testing result showed that all 5 folds were over 98.5% accuracy for both Adam and SGD optimizers. It also found that a gradient-weighted class activation mapping (Grad-CAM) was a good technique to visualize the surface failure locations of steel sheets. The findings indicated the ability of the proposed method to automatically classify the steel surface defect statuses.

Keywords: damage assessment, deep learning, convolutional neural network, transfer learning.

Collapse Analysis Of Inelastic Nonlinear Steel Frames with Bracing System Using Advanced Analysis Method

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Abstract. This study aims to use the advanced analysis method to analyze the collapse of inelastic nonlinear steel frames with bracing systems under static loadings. In this paradigm, the stability functions resolved from a closed-form solution of a beam-column element are used to represent its geometric nonlinearity. Moreover, the material nonlinearity is also considered by the refined plastic hinge approach which is based on Column Research Council (CRC) tangent modulus concept and Orbison yield surface. Meanwhile, the updated Lagrangian formulation is utilized to model the geometric nonlinearity of truss-like bracing members. In addition, the inelastic post-buckling behavior is also taken into account. A Python-programmed code structure is done to investigate the bracing system effect on the collapse of a two-story space frame.

Keywords: collapse analysis, steel frames, bracing system, geometric and material nonlinearities, python.

Compare the Efficiencies of Kriging and RBF Approximation Methods

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Abstract. Design Optimization is research area which was carried out a lot in the world, with many applications in the specifications of mechanical engineering, aerospace engineering, civil engineering. This area can help the engineering designs to be improved and optimized. Executing the global optimization codes is a time-consuming activity in engineering designs, hence the researchers should utilize the approximation methods. In this article, the authors will do novel research about comparing the efficiencies of 2 approximation methods Kriging and Radial Basis Function (RBF). The 2 approximation methods will be compared in some aspects, such as the accuracy of the methods, the robustness of the methods, the computational cost of the methods. The methods will be applied to approximate several complicated mathematical functions. It is investigated that Kriging is more accurate and robust than RBF in finding the approximations. Kriging can produce the approximations which are closer to the exact solutions, Kriging can make the approximations with less errors than RBF. However, Kriging takes more computational cost than RBF, Kriging is more time-consuming than RBF. In summary, each method has its own strengths and weaknesses. The users should choose an appropriate method depending on their different purposes.

Keywords: Kriging, Radial Basis Function (RBF), accuracy, robustness, computational cost.

Computational Geometric and Discrete Fourier Series Approaches for Particle Shape Analysis

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Abstract. Granular materials in nature possess a wide range of morphologies, varying from very round to highly irregular shapes. It has been reported that the morphological characteristics play a crucial role in the interlockings or arrangements of the particles, which affect the mechanical behaviour of granular material during compaction, consolidation and conventional monotonic, cyclic loadings, etc. Therefore, knowing quantitative parameterisation of particle's morphological properties is very important for the macro- and micro- investigations of granular materials, especially for the discrete element methods (DEM). However, it is challenging to quantify the morphological properties for highly angular particles by traditional methods such as visual inspection, etc. This study adopted a numerical method to analyze the parameterisation of morphological properties by using computational geometric and discrete Fourier series (FS) approaches. Using a 2-dimensional SEM image with a high density of the boundary points, a complex particle shape was re-constructed. The re-produced points are used for corner detection and computationally measuring some particle shape descriptors. From the results, for complex particles, the FS degree is recommended should be higher than 15 for good results. Besides, the roles of some shape descriptors in geomechanics are discussed to provide some remarkable points for readers on the influences of particle properties on the behaviour of granular materials.

Keywords: particle shape, shape descriptors, Fourier shape descriptors, micromechanics.

Consolidation Behavior of a Soft Ground Improved by Vacuum Preloading Method at Ca Mau Electric Power Plant, Vietnam

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Abstract. Vacuum preloading method was invented long time ago. However, this method has not been widely applied in Vietnam. This paper presents the improvement work by vacuum preloading method at Ca Mau electric power plant, Viet Nam. The project is located at the Mekong Delta, which is well-known by the thick layer of soft clay. The finite element method has been applied to analyze the vacuum induced consolidation process. The comparison between predicted results and monitored results showed a little difference between these two results. Based on the monitored settlements and pore water pressures, the back analysis showed the considerable difference between the real value and design value of the coefficient of horizontal consolidation. The further analysis of settlement showed the ability of reducing preloading time by vacuum pumping as compared with fill preloading method. From the studied results, the conclusions and the proposals are presented for the improvements at Ca Mau electric power plant, Viet Nam**.**

Keywords: vacuum preloading, soft soil, consolidation, finite element method.

Crack Detection using Acoustic Emission Sensors and Convolutional Neural Networks

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Abstract. Structure deterioration is regarded as one of the crucial problems in the construction industry. One method of detecting cracks in concrete structures is using acoustic emission sensors. The conventional acoustic emission sensor-based approach concentrates on measuring the Time of Arrival, Time Difference of Arrival, and Received Signal Strength Indicator. However, these conventional methods are susceptible to a high degree of error due to the presence of inhomogeneous materials. In this study, we propose a new, deep learning-based method for detecting cracks using AE sensors. The objective of this method is to automate the process of detecting cracks and improve accuracy. The proposed method involves the following steps: collecting acoustic emission sensor signals and transforming them into a time-frequency representation using Continuous Wavelet Transform. Next, these representations are inputted into a Convolutional Neural Network that has been designed to localize the crack. Lastly, the trained Convolutional Neural Network is utilized to estimate the coordinates of the crack. The effectiveness and progressiveness of the proposed method were validated through tests on a concrete block with an artificially created crack caused by pencil-lead breaks.

Keywords: acoustic emission sensor; deep learning; convolutional neural network; crack detection; structural health monitoring.

Crack Identification on Reinforced Concrete Slabs Using Modal Strain Energy Method

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Abstract. Damage identification in plate-like structures considering the nonlinear behavior of the material is essential in the civil engineering field. This study proposes a procedure based on the modal strain energy (MSE) change to detect crack's occurrence and development on the reinforced concrete slabs subjected to uniform loads. The MSE values are calculated from mode shape data acquired from modal analysis by ANSYS software. The slab's cracks occur and develop according to the increase of the load. A reinforced concrete slab subjected to uniform loads is used to verify the proposed procedure's effectiveness with several damage levels. The results show that the proposed procedure identifies the crack's location even if the structure works in the nonlinear phase.

Keywords: crack, damage identification, modal strain energy, nonlinear, reinforced concrete slab.

Cyclic Horizontal Loading Tests of New Connection Systems Using A Single Anchor Bolt for Steel Roof Bearing

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Abstract. In Japan, not a few gymnasia have been damaged in every major earthquake, i.e., the 1995 Hanshin quake, the 2011 Great East Japan earthquake, and the 2016 Kumamoto earthquake, even though these facilities were designated specifically as disaster shelters. One major structural type of a Japanese gymnasium is a reinforced concrete frame with a steel roof structure on the top. The style is commonly adopted when a gymnasium has some rooms on the first floor for activities such as martial arts and physical training, with an arena on the second floor. As a bearing connection for a steel roof structure, an exposed-type connection is mostly adopted, with base plates of a roof structure connected by sets of anchor bolts embedded into the top parts of RC columns. During earthquakes, the tall RC frames surrounding the arena behave as cantilever components so that not only the steel roof structure but also the RC frame tends to deform toward the out of plane direction independently. Consequently, the roof bearing connections tend to be damaged by ruptured anchor bolts and by concrete breakout because of a lack of edge distance between the concrete surface and the embedded anchor bolts. To increase the shear strength of the connection, it is proposed that an anchor bolt be arranged at the center of the RC column and be stiffened by welding steel plates to prevent its flexural yielding. A series of static tests was conducted, with results showing that the ultimate shear strength of conventional connections is determined by concrete breakout, whereas those of the proposed connection exceeded the design shear strength of the RC column.

Keywords: concrete breakout strength, cyclic loading test, exposed-type base connection, gymnasium, seismic damage

Damage Detection of Frame Structures Based on Acceleration Using Deep Learning

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Abstract. In this work, a damage detection method for frame structures based on time-history acceleration data using a deep learning (DL) technique is presented. For that aim, a dataset randomly created by finite element analysis (FEA) is employed to build the learning model based on a deep neural network (DNN). In which, inputs are the time-series acceleration at several degrees of freedom (DOFs) of a structure, while outputs are damage ratios of frame members. The accuracy of the trained and tested DL models is continuously updated by eliminating low-risk members which are predicted in a previous DL model via a damage threshold. Accordingly, the proposed methodology can reliably diagnose the location and severity of damaged members. Several examples programmed by Python are exhibited to validate the reliability of the suggested paradigm.

Keywords: damage detection, frame structures, acceleration, deep learning, python.

Detection of Plastic Hinges in Inelastic Nonlinear Steel Frames Using Deep Learning

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Abstract. This study presents a numerical method based on deep learning techniques for detecting plastic hinges in inelastic nonlinear steel frames under static loadings. In which, a dataset randomly generated by an advanced analysis method is utilized for the training and testing processes of deep learning (DL). The geometric nonlinearity including the *P-δ* and *P-Δ* effects is considered by the stability function, whilst the material one is taken account of Column Research Council (CRC) tangent modulus concept and Orbison yield surface based on the refined plastic hinge approach. Accordingly, the plastic hinge information can be easily traced via the Orbison yield surface. A benchmark two-story frame is exhibited to demonstrate the reliability of the proposed methodology. Obtained outcomes indicate that the plastic hinges in inelastic nonlinear steel frames can be directly diagnosed by DL techniques such as Deep neuron network (DNN) and Extreme Gradient Boosting (XGBoost) without using incremental-iterative algorithms. All investigated cases are programmed by Python.

Keywords: deep learning, plastic hinges, inelastic nonlinear steel frames, orbison yield surface, python.

Developing A Constitutive Model Considering Fabric Anisotropy under Monotonic Undrained Loading

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Abstract. Developing a constitutive model for granular material under undrained condition is becoming more popular nowadays because granular materials behave differently under different loading conditions. There have been many studies on the current soil material model. However, most of these soil constitutive models have some drawbacks such as that these soil models can describe the granular materials under certain loading conditions, input parameters used in the model must be adjusted, and the fabric anisotropy evolution is not developed properly. In this study, a soil material model is developed based on an effective and popular constitutive model and focuses on overcoming the obstacle where the Poisson's ratio is adjusted from experiments to fit the laboratory loading curves and the fabric anisotropy in the model is not evolved properly. This developed model will use the actual Poisson's ratio of the soil, and the fabric anisotropy evolution and dilatancy parameter will be developed. By comparing the simulation results of the original model and the developed model with the experimental results, we observed that when using the experimental value of Poisson's ratio, the developed model can overcome the underestimation of the dilatancy under undrained condition. These results play an important role in the development of a constitutive model of granular behaviours, allowing researchers to further improve the developed model to be able to simulate other granular behaviours.

Keywords: constitutive model, fabric anisotropy, granular material, monotonic loading, experimental result.

Dynamic Analysis of Composite Plate Subjected to Moving and Thermal Loads by Using Moving Element Method

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Abstract. The objective of this research is to establish a numerical method that is computationally efficient and capable of performing dynamic analysis on a laminated composite plate that is supported by a Pasternak foundation and exposed to both thermal and moving loads. It is postulated that the temperature remains constant on the surface and exhibits variation mainly along the direction of the plate thickness. The temperature distribution function is utilized to estimate the distribution of temperature. The principle of superposition is utilized to determine the strain of the composite plate that is influenced by both thermal and moving loads. The composite plate's motion equation is derived through the application of the principle of virtual work. The moving element method (MEM) is utilized to discretize the equation, and subsequently, the Newmark numerical technique is employed to solve the entire system of the problem. Upon conducting an analysis of the convergence of numerical solutions and validating them through benchmark cases, the obtained solutions are employed to examine the impact of temperature on the dynamic response of the laminated composite plate under various temperature change scenarios. An increase in temperature was found to result in an increase in the maximum displacement of the composite plate.

Keywords: laminated composite plate, moving element method, MEM, thermal load, temperature.

Effects of Temperature on the Dynamic Analysis of Multi-layer Mindlin Plates Subjected to Moving Loads

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Abstract. In this paper, the influence of temperature on the dynamic analysis of Multi-layer mindlin plates subjected to moving loads was further studied by investigating the plate parameters at different temperatures. Research using moving multilayer plate method (MMPM) has developed more thermal algorithms to investigate the influence of temperature. Assume that the temperature field varies only with the thickness of the plate, constant on the surfaces. The total deformation of multilayer plate due to mechanical load and temperature is determined using the superposition principle. The equation of motion of the multilayer plate element is established based on the principle of virtual work. Then using MMPM, discretizing the plate by moving multi-layer mindlin plate elements obtains an equation for a plate element, which gives the formula for stiffness matrix, mass matrix, load vector, etc. specific to each element. Assembling all the elements of the multilayer plate, the general equation of motion is obtained and solving this equation of motion by the Newmark method. After the proposed model is verified with the available benchmark solutions, the study will investigate the displacement of the plate when changing the parameters of the plate in different temperatures. Research results will provide the displacement of the multilayer plate at different temperatures when changing the parameters of the plate as well as showing the trend of each parameter when influenced by temperature.

Keywords: multi-layer moving plate method, MMPM, multi-layer Mindlin plate, moving load, temperature.

Evaluating the Stiffness Deterioration of Slab Structures Using Deformed Shape Data

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Abstract. This study presents a diagnostic technique using simply node displacement to identify the loss of stiffness of slab structures, with the goal of advancing efficient building health monitoring approaches. The method is based on the correlation of slab deformation measurements made in two damaged and undamaged states. To be more precise, the diagnostic signs DAC and DBI are frequently employed to assess whether decreased stiffness is present. To test the sensitivity of the indicators in detecting plate damage, various failure scenarios are assumed. The findings show that the derived diagnostic indices based on the nodal displacement of the homogeneous slab examined in this work can be used to detect and locate the local stiffness deterioration of slab structure.

Keywords: reinforced concrete slab, deformed shape, damage detection, stiffness deterioration, structural health monitoring.

Finite Element Analysis of Shearhead Connections Between Flat-Slab and CFT Column

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Abstract. This study is dedicated to developing a numerical model simulating the punching shear behavior of shearhead connections between Concrete-Filled Steel Tabular (CFT) columns and Reinforced Concrete (RC) flat-slab. A three-dimensional Finite Element Analysis (FEA) model is developed using ABAQUS, which incorporates the fundamental Concrete Damage Plasticity (CDP) model for concrete and the isotropic plasticity model for steel. The simulation outcomes are validated with experimental results and it is shown that the numerical model can provide acceptable results of load-displacement relations and failure modes of structural components. Parametric studies are also conducted to investigate the influence of mesh size, element types, parameters of CDP, and constitutive relations of concrete on the simulation results.

Keywords: concrete damage plasticity; reinforced concrete flat-slab; shearhead; punching shear; finite element analyses

Finite Element Model for Nonlinear Behavior Analysis of Reinforced Concrete Slabs Repaired with CFRP Rods Using the NSM Technique

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Abstract. This study aims to propose a three-dimensional finite element model of the three-point bending test for a reinforced concrete slab that has undergone fire damage and subsequent repair using the CFRP rod repair system under the NSM technique. The ANSYS/Workbench software will be utilized for this purpose. The CPT215 elements enhanced by the CDPM material model are employed to simulate the nonlinear behavior of concrete materials. Additionally, the behavior of reinforcing steel rebars is simulated using the REINF264 embedded elements. The adhesive behavior between the CFRP rod repair system and the concrete material will be simulated using the bi-linear cohesive zone model (CZM) through the contact elements. The parameters of the CDPM material model and the CZM model are proposed appropriately for the scenario where the CFRP rod repair system is fully embedded within the concrete material. Once the proposed finite element model has been validated with previous experimental findings, it will be employed to assess the effectiveness of the CFRP rod repair system in repairing and strengthening the fire-damaged reinforced concrete slabs.

Keywords: CDPM model; bi-linear CZM; NSM technique; fire-damaged RC slabs; CPT215 element; REINF264 element.

Floating Environmental Deck Structures - Design Construction Challenges

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Abstract. Grand Waterfront living is popular throughout the world including Singapore. The Reef at King's Dock (RKD) condominium project, featuring a 180-metre-long floating sundeck with swimming pools, promises to provide residents and guests a spectacular seaside experience. The pre-stressed concrete pontoon based floating structure has a design life of 50-year with minimum maintenance. The RKD floating sundeck is 180m long, 11.7m wide and assembled using three separate 60m long concrete modules end to end. The module depths varies from 5.0m to 5.2m. The structure is designed to float in water depth of 8.3m and 12.5m in low and high tide respectively. The floating sundeck is cast off-site and towed to is final location. The whole sundeck is targeted to be completed in 2024 and will become the region's first floating swimming pool and one of the largest concrete floating structures in the region.

Free Vibration Analysis of Relatively Thick Functionally Graded Plates under Thermal Environment by Using a Meshfree Method

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Abstract. In this study, the free vibration behavior of functionally graded (FG) plates under a thermal environment is investigated based on a meshfree method and the Reissner-Mindlin plate formulation. FG material (FGM) is a special composite composed of two constituents, ceramic and metal, that possess continuous material properties variation in a certain direction. Particularly the material properties of FG plates in this paper have the power-law distribution through the thickness. Besides, the temperature is an important aspect that significantly affects the change in mechanical properties of FGM. Therefore, it is necessary to examine the mechanical behavior of FG plates in a thermal environment with different temperature conditions to better understand the influence of temperature on this kind of material. The meshfree concept used in this paper is the Radial Point Interpolation Method (RPIM) which satisfies the desirable Kronecker delta property. And the well-known Reissner-Mindlin plate theory is employed to construct the formulation for the relatively thick FG plates in the study. The natural frequencies and mode shapes of FG plates subjected to homogeneous temperature change are presented through various numerical examples. The obtained results show that the ambient temperature and the FGM volume fraction index are the parameters affecting the free vibration behaviour of the plates. The obtained numerical results are all compared with other references and show good agreement.

Keywords: free vibration, functionally graded material, radial point interpolation method, Reissner-Mindlin plate, thermal environment.

Free Vibration Analysis of Sandwich Nanoplate Including Fg Piezoelectric Face Sheets and Metal Foam Core

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Abstract. The article deals with the free vibration characteristics of nano sandwich plates based on nonlocal elasticity theory and four-variable refined plate theory (HSDT4). The nano sandwich plate consists of a core layer of metal foam and two face sheets of functionally graded piezoelectric material (NSP-FGPie). The electric potential is assumed to vary with the thickness of each layer of the piezoelectric according to a cosine function. The governing equations of simply supported NSP-FGPie are established based on Hamilton's principle and solved using the Navier solution. The accuracy and reliability of the formulation and solution are verified through verification studies. Numerical investigations are carried out to evaluate the influence of material characteristics, geometrical dimensions, piezoelectric effects and nonlocal parameters on the free vibration frequency of the NSP-FGPie.

Keywords: vibration, nano sandwich plates, functionally graded piezoelectric, four-variable plate theory, nonlocal elastic theory.

Free Vibration and Dynamic Responses of Bidirectional Functionally Graded Plates with Piezoelectric Layers under Moving Mass

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Abstract. This paper investigates the free vibration and dynamic response of bidirectional functionally graded plates with piezoelectric layers excited by moving mass. The plate is made of bidirectional functionally graded material (2D-FGM) with metal and ceramic constituent materials whose mechanical properties vary in both thickness and longitudinal directions according to the power law. For the analysis purpose, a finite element model using a four-node rectangular element with eight mechanical and two electrical degrees of freedom per node based on the four-variable refined plate theory (HSDT4) and Hamilton's principle is derived. The Newmark method is used in computing the vibration response. The obtained results are compared with available data to demonstrate the accuracy and convergence of the model. Some new numerical examples are performed to investigate the influence of material, velocity, the weight of moving mass, and electrical and mechanical boundary conditions on the free vibration and dynamic responses of the piezoelectric 2D-FGM plates.

Keywords: 2D-FGM, piezoelectric, vibration, dynamic response, moving mass, fem.

High Performance Steel-Concrete Composite Beam System for Sustainable Construction

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Abstract: It has been agreed that buildings and infrastructure around the world should target 40% less embodied carbon by 2030. However, there is no single material that can meet this target now in terms of performance, availability and productivity. This study presents a hybrid approach using high performance green concrete and optimized steel concrete composite flooring system for heavily loaded & long-span industrial or commercial buildings. The composition actions are formed between green concrete slab in grade C60/75 and pre-engineered structural steel asymmetric sections in grade S460M. Feasibility study was conducted on the concept level using the EC4 design approach and trial production and testing was carried out to verify its mechanical performance. A case study using a local industry building project shows the proposed solution could achieve 30% reduction on embodied carbon and 37% reduction on self-weight. To verify the compatibility among the three different materials used, i.e., the S460M structural steel, green C60/75 concrete, and the shear studs, shear connection specimens designed and tested with reference made to EC4. Subsequently, A full scale steel concrete composite beam is tested until failure. Finite element model is also built to validate the test results and study the parameters. The results showed that the EC4 design equations for predicting the shear resistance and the bending moment resistance are still conservative for the materials and full-scale beam.

Keywords: Steel concrete composite beam, Pre-engineered sections, sustainable construction, Low embodied carbon, long-span

Hydrodynamic Performances of Pile-restrained Floating Breakwaters with Arbitrary Plan Shape

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Abstract. This paper is concerned with hydrodynamic performances of pile-restrained floating breakwaters of the same material volume, but with different plan shapes. The performances are evaluated in terms of the wave attenuation performance and the breakwater heave motion. The wave attenuation performance is assessed by using the mean transmission coefficient or the upper limit of the 95% confidence interval of the transmission coefficients in the breakwater's leeside. The transmission coefficients and the breakwater motion are obtained from numerical simulations based on the linear wave theory and the Mindlin plate theory. The hybrid Finite Element – Boundary Element (FE-BE) method is employed for solving the fluid-interaction problem, and its accuracy is verified by comparing with available published results. It is found that by altering the breakwater plan shape, the wave attenuation performance may be improved by up to about 60%, and the breakwater heave motion may decrease by more than 90% when compared to those of the conventional straight breakwater.

Keywords: floating breakwater, wave attenuation performance, transmission coefficient, arbitrary plan shape

Improvement of Pavement Foundation with Different Methods: A Case Study

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Abstract. During the design process of pavements, soil characteristics are important to obtain the technical indicators and also the economic viability of roads. However, critical distress of pavements, i.e., cracks, rutting, potholes, and lateral shear failure at the edge are often caused by underlying soil with poor quality. In order to avoid or reduce the aforementioned defects, methods have been proposed to improve the pavement foundation, such as compaction techniques, soil reinforcement using cement, fly ash, soil bag, geogrid, soil stabilization, etc. Nevertheless, their performance needs to be demonstrated under field conditions as well as under domestic geological conditions, which motivates the present study to design and conduct full-scale field experiments in Vietnam focusing on two advanced methods, i.e., soil bag, and multi-axis geogrid. Consequently, the initial evaluation of the performance of the two above methods in improving the pavement foundation is presented. In addition, the main features of the soil bag, and multi-axis geogrid methods are also clearly shown in this work.

Keywords: soil bag, multi-axis geogrid, pavement foundation, soft soil.

Investigation of Reduction in Ultimate Shear Strength of I-curved Girder

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Abstract. Curvature greatly complicates the behavior of horizontally curved steel girders used in bridges. This study investigates web overall buckling of steel I-curved girder subjecting pure shear with extensive parameters of web slenderness (D/t_w=200), and with panel aspect a/D ratios of 1. The radius of the girders studied is 50.8, 70, 101.6, 300 (m), and infinity (the straight girder) as well. The single isolated panel including the flange is modeled using the finite element package ABAQUS. All models are carried out with the ratio of the flange to web thickness t_f/t_w of 3. The analytical results are compared with the current design practices of AASHTO LRFD. It was observed from the present study that the equation for the shear buckling coefficient of a straight girder web panel (Lee et al., 1996) can be used conservatively for curved web panels. However, the post-buckling behavior for curved girder web is different from that of straight girder and the difference becomes more significant for girders with larger curvature.

Keywords: web buckling, post buckling strength, I-curved girder, ultimate shear strength.

Restraint Effect on Lateral Buckling Load of Continuous Braced H-Shaped Beams based on Partial Frame Loading Tests

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Abstract. In actual space structures, slender beam sections are utilized for main beams to increase the bending stiffness and strength effectively. In general, beams in a space structure possesses continuous braces such as the folded roof plates on the top flange. These non-structural members are not considered as the lateral or rotational braces; however, they may provide the restraint effect preventing the lateral buckling of beams. Further, the beams are generally jointed to the box-section column possessing a high torsional rigidity. Consequently, the beam receives a warping restraint at beam to column joints by virtue of the column St Venant's torsional rigidity, resulting in the enhancement of lateral buckling strength. In this paper, partial frame tests of H-shaped beams subjected to cyclic loading are conducted. In the experiment, eleven specimens are conducted to clarified that bracing effect of the folded roof plates and warping restraint effect of beam-column joints on lateral buckling strength and deformation performance of H-shaped beams. Furthermore, The Relationship rotational moment performed by the folded roof plates and warping restraint of beam-column joints is clarified.

Keywords: H-Shaped Beam, Warping Restraint, Beam-Column Joints, Continuous Braces, Lateral Bucking Strength.

Moving Element Method in the Dynamic Analysis of Functionally Graded Material Plates Subjected to Thermal Loads and Resting on A Variable Stiffness Foundation

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Abstract. In this paper, a Moving Element Method (MEM) is developed to study the dynamic behavior of functionally graded material plates (FGMs) subjected to thermal and mechanical loads. In general, the moving element method is an improvement of the finite element method for moving load problems. Compared to previous literature, the new point presented in this paper is that the foundation supporting plate has variable stiffness along the entire length. Furthermore, due to temperature change, the thermal load is added to the overall load vector. Also, the plate's overall mass, damping, and stiffness matrices are derived. Finally, the Newmark method is employed to solve the equations of motion. To verify the accuracy of the proposed method, the result of the analysis obtained from MATLAB is compared with SAP2000. Next, the FGM plate is analyzed in circumstances of variable foundation stiffness with moving load and thermal load acting at the same time.

Keywords: moving element method, functionally graded material, variable stiffness, temperature effect, newmark method

MMPM for The Dynamic Analysis of Multi-layer Connected Plates Subjected to Arbitrary-Direction Moving Loads

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Abstract. The Multi-layer Moving Plate Method (MMPM) is established in this paper to investigate the dynamic behavior of a multi-layered connected plate sitting on a Pasternak foundation and subjected to arbitrary-direction moving loads. The governing motion equations of the multi-layered connected plate are derived based on the principle of virtual work, then discretized by using multi-layered moving elements, and the final system motion equation is solved by the Newmark numerical method. The new point presented in this paper is that the load can move in any direction on the plate. Some benchmark solutions are used to verify the proposed model's results. Then, the dynamic analysis of a multi-layered connected plate is investigated under an oblique direction moving load. The obtained results pointed out that the magnitude of the displacement around the applied loading point is the same; however, it tends to deviate in the motion direction. The maximum displacement value is independent of the moving load's direction.

Keywords: Multi-layered Moving Plate Method, MMPM, dynamic analysis, moving load, arbitrary direction, Newmark method.

Multi-Layer Moving Plate Method MMPM for the Dynamic Model of Two-Layer Plates Subjected to Moving and Thermal Loads

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Abstract. In this paper, a computationally efficient numerical technique capable of modeling the dynamic behavior of a multi-layer plate resting on a Pasternak foundation subjected to moving loads and temperature has been established. It is assumed that the temperature distribution remains uniform on the surfaces while exhibiting variation across the thickness of the plate. The temperature distribution function can be obtained through the solution of the governing equation for heat transfer. The total strain from the mechanical loads and temperature of the multi-layer plate is determined by the principle of superposition. The multi-layer plate's governing motion equation is initially formulated through the principle of virtual work and subsequently discretized with the Multi-Layer Moving Plate Method (MMPM). After that, the global motion equation for the multi-layer plate is derived through the assembly of all constituents of the multi-layer plate elements, and finally, the system equation is resolved via the Newmark numerical technique. After the proposed model is verified with the available benchmark solutions, the influence of temperature on the dynamic behavior of the multi-layer plate is investigated. The displacement of the multi-layer plate was found to be temperature-dependent.

Keywords: multi-layer moving plate method, MMPM, multi-layer plate, moving load, temperature.

Multiple Penny-Shaped Planar Nano-Crack Interaction in 3D Elastic Infinite Medium

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Abstract. The present study aims to examine the behavior of multiple penny-shaped planar nano-cracks within a three-dimensional elastic infinite medium. The integration of the Gurtin-Murdoch surface elasticity theory with the conventional linear elasticity theory is employed to establish a mathematical framework capable of comprehensively representing the phenomena occurring at the nanoscale. The determination of the numerical solution for the coupled system is achieved by combining a conventional finite element method with a symmetric Galerkin boundary element technique. The findings indicate that the interaction among nano-cracks can lead to either an enhancement or a mitigation of the mechanical responses, such as the crack opening displacement and the stresses near the front of the nano-sized cracks.

Keywords: gurtin–murdoch model, nano-crack, multiple crack interactions, SGBEM, surface stresses.

Natural Frequency-Based Prestress-Force Estimation for Post-Tensioned Prestressed Concrete Beams

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Abstract. This paper presents a method to estimate the prestress-force in post-tensioned prestressed concrete beams by using the fundamental natural frequency. Firstly, a theory of the relation between the prestress-forces and the fundamental natural frequency in a post-tensioned prestressed concrete beam with parabolic tendon is described. Secondly, a three-dimensional finite element model for dynamic analysis of the prestressed concrete beam is modeled by using finite element method. Thirdly, the analytical natural frequencies are compared to ones from the theory and from the experimental results. Finally, the prestress-forces are estimated by using the natural frequency.

Keywords: Prestress-force, Prestressed Concrete Beam, Fundamental Natural Frequency, Vibration, Structural Health Monitoring.

Nonlinear Settlement Prediction of Axially Loaded Pile Group Using Load-Transfer Method

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Abstract. An investigation of the nonlinear settlement of axially loaded pile groups using a novel load-transfer method is presented in this paper. The exponential model and slippage are adopted to describe the relationship between shear resistance and displacement at the pile shaft. The exponential model also selects to represent the response at the pile tip. The reaction of a single axially loaded is first determined. Then, the performance of the axially loaded pile is investigated using the single pile response combined with pile-soil-pile interaction. The verification of the proposed load-transfer method is implemented with field test data. The comparison shows a well-agreement between nonlinear prediction settlements and those obtained from monitored data.

Keywords: nonlinear settlement, axially loaded pile group, load-transfer, slippage.

Numerical Modelling of Punching Shear Behavior of UHPFRC Flat Slabs

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Abstract. Ultra-high performance fibre reinforced concrete (UHPFRC) can be used to improve the punching shear behaviour of slab-column connections due to its outstanding mechanical properties as compared with conventional concrete. Therefore, this study is aimed at investigating the punching shear behavior of flat slabs made of UHPFRC. The test specimens subjected to punching shear in the previous studies were collected for the simulation. A non-linear finite element (FE) model was developed using ABAQUS software to simulate the punching shear performance of UHPFRC flat slabs. The FE model was validated against experimental results in the literature. The comparison of the force-displacement curves between the FE model and test results showed that the FE model can accurately predict the punching shear behavior of UHPFRC flat slabs. Furthermore, the punching shear strengths obtained from the FE model were compared with those predicted using current standards. The current standards underestimated the punching shear strengths as compared to the FE model and test results.

Keywords: flat slabs, punching shear, UHPFRC, FE model, ABAQUS. keywords.

Numerical Simulation of Reinforced Concrete Frame With Open-Infilled Brick Wall

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Abstract. In this paper, a 3D numerical model is developed to simulate the behavior of a Reinforced Concrete (RC) frame infilled with open walls. The numerical model is developed based on commercial finite element software ABAQUS, which is equipped with adequate plasticity-based constitutive models to develop a simplified micro-model approach. The elastic and plastic behavior of joints between bricks is simulated by using a surface-based cohesive response, while the Drucker Prager plasticity model is utilized to model the crushing of the brick under compression. The default concrete damage plasticity model and isotropic plasticity model are used to represent the constitutive relations of concrete and reinforcing bars, respectively. By validating the simulation outcomes with experimental results, it is found that the proposed numerical approach can be used as an efficient alternative means to analyze the behavior and failure modes of a reinforced concrete frame with infilled walls.

Keywords: simplified micro-model, reinforced concrete frame, infilled wall, abaqus, in-plane load.

Parametric Analysis of Wind Load Effects on Buildings Based on Vietnamese Standards

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Abstract. Among load types acting on buildings, the determination of wind load is critical because of its dependence on building height, building shapes, and topography. This study presents a parametric analysis of wind load effects on buildings using Vietnamese standards. First, the fundamentals of wind-load estimation methods based on gust loading factor and equivalent static wind load are briefly described. Second, finite element (FE) models of buildings are conducted to obtain modal parameters of buildings for wind load calculation. Effects of building parameters on wind load estimation are analyzed using guidelines from the standards. The result demonstrates that wind loading calculated from the gust loading factor is higher by about 30% than that of equivalent static wind load for building heights lower than 40 meters. For tall buildings, the two methods yield relatively significant differences (about 15%) in wind load values. It suggests that the gust loading factor should be applied to the structural design of buildings to improve structural safety under changes in natural environmental conditions.

Keywords: wind load estimation, tall building, gust effect factor, structural safety, FE analysis.

Post-Earthquake Damage Assessment of Building Based on Deep Learning

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Abstract. Evaluation of the severity of structural damage caused by earthquakes is time-consuming using labor-intensive approaches. Deep learning methods have been increasingly used to detect and classify image damages, whereas few studies have been applied to assess the level of damaged structural images such as no, light, moderate, or severe damages under earthquakes. The goal of this paper is to propose an approach to automatically categorize the structures using convolutional neural networks (CNNs). Two pre-trained CNNs, namely InceptionV3 and Xception were employed via transfer learn-ing. Adaptive moment estimation algorithm (Adam) was adopted to optimize the parameters of deep learning models. A gradient-weighted class activation mapping (Grad-CAM) was applied for locating damages. The testing results highlighted that InceptionV3 and Xception algorithms showed a high performance with 86.67 % and 88.33 % accuracy, respectively. The Grad-CAM located successfully the actual damages to structures. It depicts the ability to use CNNs for the assessment of structural damages using images.

Keywords: damage assessment, deep learning, convolutional neural network, pre-trained model.

Predicting Confined Compressive Strength of Concrete Using Machine Learning Approach

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Abstract. The purpose of this research is to develop a machine learning model, namely random forest model (RF), for estimating the best confined compressive strength of concrete. In this study, a total of 144 experimental results on the confined compressive strength of concrete were collected from the literature and employed to develop the RF model. The results of the RF model were compared with those of the normal regression model, namely multiple linear regression (MLR). Regarding the analysis result, it is highlighted that the developed RF model in this article can predict the confined compressive strength of concrete more accurately than the MLR model. Also, the effect of input parameters on the confined compressive strength of concrete estimation was explored based on the sensitivity analysis. The results shown that the two parameters, comprising compressive strength and diameter and thickness of tube ratio were found to be substantially important to forecast the confined compressive strength of concrete.

Keywords: random forest model, multiple linear regression, confined compressive strength, sensitivity analysis.

Segmentation of Concrete Surface Cracks Using DeeplabV3+ Architecture

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Abstract. Concrete is a common construction material used in structural engineering, but it is prone to cracks which can negatively impact the quality and longevity of structures. Therefore, timely and accurate detection of cracks in concrete surfaces is an important task in structural health monitoring. Currently, deep learning has emerged as a powerful technique in different fields due to its ability to learn from large data sets, recognize patterns, and make accurate predictions. The aim of this study is to suggest an effective backbone solution for the concrete surface crack detection task using DeepLabv3+ architecture. Specifically, seven different backbones investigated in this study were MobileNet-v2, EfficientNet-b0, ResNeXt50-32x4d, timm-regNetx-002, timm-regNety-002, timm-gerNet-s, timm-efficientNet-b0. For the training process, we used the Adam algorithm for updating the weights of the model and the Dice loss function as the objective function. The study results show that all backbones effectively detected concrete cracks with over 92 % Intersection over Union (IoU). The ResNeXt50-32x4d presents the best performance of 93.8 % IoU. The findings highlighted the feasibility and effectiveness of models in concrete crack segmentation tasks.

Keywords: semantic segmentation, concrete crack, transfer learning, deeplabv3+, deep learning.

Semantic Segmentation of Cracks Using DeepLabv3+

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Abstract. Detecting cracks of structures are a crucial role in the structural health monitoring. Destructive techniques and non-destructive approaches have been widely used to evaluate the structural health. Recently, a deep learning-based approach is developed for noncontact inspections. The goal of this paper is to suggest an efficient backbone of Resnet family in terms of crack detections using DeepLabv3+ architecture for the structural health monitoring. Five kinds of backbones, namely Resnet-18, Restnet-34, Resnet-50, Resnet-101, and Resnet-152 were implemented in this study. Adaptive moment estimation (Adam) optimizer and dice loss function were applied to train the models. In addition, the mean intersection over union (IoU) was employed to investigate the accuracy of proposed models. The study results show that all backbones effectively detected the concrete cracks with over 90 % IoU. The Resnet-50 presents the best performance of 93.5 % IoU for DeepLabv3+ architecture. The findings highlighted the feasibility of proposed method in terms of structural crack detections.

Keywords: crack detection, semantic segmentation, deeplabv3+, deep learning.

Simulation of the Nonlinear Behavior of Strengthened RC Columns under Pure Axial Compressive Load using the CDPM Model

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Abstract. This study aims to apply the Coupled Damage-Plasticity Microplane (CDPM) model to simulate the nonlinear behavior of reinforced concrete (RC) columns strengthened by a steel jacket, including the steel angles and the prestressed steel straps. A three-dimensional finite element model of a strengthened RC column subjected to a static pure axial compressive load is simulated in the ANSYS Workbench software. The CPT215 solid elements with eight nodes that are improved by the CDPM material model are used to simulate the nonlinear behavior of the concrete part, while the REINF264 embedded elements are used to simulate the reinforcement behavior of longitudinal rebars. The most appropriate parameters of the CDPM model for the strengthened RC columns are proposed. The finite element model is validated by the experimental results of previous studies and is then utilized to investigate the influence of the strengthening system on the bearing capacity of the RC columns.

Keywords: coupled damage-plasticity microplane model; strengthened reinforced concrete column; pure axial compressive loading; CPT215 element; REINF264 element.

Stress intensity factor solution for fractured steel W-shaped beams considering non-overlapping cracking behavior

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Abstract. In this study, the stress intensity factor (SIF) equation for the non-overlapping web cracks in W-shaped beams is developed based on the symbolic regression which performs on the data obtained from finite element (FE) analyses. The symbolic regression is constructed via the genetic programming (GP). The non-overlapping SIF solution in this study is dependent on beam flange-to-web area ratio, web crack length and crack eccentricity. In the current analysis, the good agreement between the predicted SIF values and the FE database is obtained when the squared Pearson's coefficients of correlation are found to be higher than 0.95. Furthermore, the obtained SIF solution is also compared with the results from previous studies to evaluate the performance of GP process chosen in the current study.

Keywords: W-shaped beam, crack non-overlapping behavior, FEM, genetic programming (GP).

Structural damage detection using reduced free vibration data and deep learning

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Abstract. This work presents a damage detection method for trusses using reduced free vibration data and multiple deep neural networks (DNNs). For this aim, a dataset randomly created by finite element analysis (FEA) is employed to build the DNN model. Inputs are a reduced free vibration dataset only including eigenvalues at several degrees of freedom (DOFs) of a few first modes, whilst outputs are damage ratios of truss members. Accordingly, the DNN requires a simpler architecture and less computational cost for the training and testing processes. By eliminating low-risk members via a damage threshold, the subsequently trained and tested DNN models become more accurate in predicting the location and severity of damaged members. A 2D truss programmed by Python is tested with two different damage scenarios without and with noise to verify the reliability and efficiency of the proposed methodology.

Keywords: deep learning, surrogate model, damage detection, free vibration data, python.

Topology, Size and Shape Optimization of Trusses Under Dynamic Behavior Using Evolutionary Symbiotic Organisms Search

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Abstract. This work presents an evolutionary symbiotic organisms search to simultaneously topology, size and shape of trusses under dynamic behavior. The problem aims to minimize the weight of a truss so that all constraints on kinematic stability, displacement, stress, Euler buckling loading, frequencies and dynamic responses are satisfied completely. For this, the spatial coordinates of nodes are treated as continuous shape design variables, whilst the members' cross-sectional area is taken account of discrete/continuous size ones. Additionally, a discrete topology pseudo-area variable is utilized to represent the absence or attendance of a truss member. Two examples of 2D and 3D trusses are illustrated to confirm the reliability and robustness of the proposed algorithm. All investigated problems are programmed by Python.

Keywords: topology, size and shape optimization, truss, dynamic, evolutionary symbiotic organisms search, python.

Ultimate Strength of Steel Pile Top Filled with Concrete Using Reduced Scale Model Test Considering Effects of Inner Ribs and Concrete-Pile Bonds

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Abstract. In the latest version of Japanese design standards for foundations, the contribution of inner ribs on the ultimate strength is calculated by substituting them with the equivalent concrete bonding effect. However, stress transmission via contact force between inner ribs and infill concrete and that via bonding force between a steel pile surface and infill concrete are not exactly the same mechanism, which may cause different mechanical characteristics especially at the ultimate state. A series of bi-axial loading tests were conducted to clarify stress transmission mechanism of concrete-filled parts of steel piles, using reduced-scale specimens. The results show that the stress transfer from the steel pipe pile to the infill concrete through the bond effect begins to decrease immediately after the steel pipe yields, and then the stress transfer through the inner ribs increases. Therefore, these two mechanisms did not work simultaneously, and inner ribs became more effective at the ultimate state.

Keywords: bond effect, concrete-filled steel pile, inner ribs, scaled model specimens, ultimate strength evaluation.

Vision-based Structural Displacement Measurement using Siamese Network

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Abstract. Structural displacement measurement can provide essential information of the structure that could be used to assess the condition of the structures. Recent computer vision technologies have provided an opportunity to obtain a more efficient way to measure the structural displacement. However, the traditional vision-based displacement measurement methods have few limitations. The user has to manually select the feature and the region of interest from the image frame and also needs to adjust parameters. Furthermore, when tracking fails, the user must manually repeat the process with new a region of interest. This procedure costs a plenty of time and effort. To overcome these limitations, this paper introduces a deep learning-based displacement measurement approach using Siamese network. The proposed method can automatically select and track feature points in the structure. To validate the performance of this method, a simulation-based experiment was conducted. The response of the 6-story building model was generated by simulation, and the animation of this building was encoded into a video. The displacement of the building was extracted by the movement of a region of interest from its original location. The validation test showed that the proposed method can not only automate the displacement measurement process, but also can get substantial accuracy of the measurement.

Keywords: vision-based displacement measurement, siamese network, deep learning.

Wind Resisting of a Solar Panel Mounting Structure with Partially Defective Pile Foundations

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Abstract. Along with the recent global trend to shift to clean energy, the number of photovoltaic power plants in Japan increased drastically by 10 times after the 2011 East Japan Earthquake. At photovoltaic power plants, tilted solar panels are mounted on light frames made of steel or aluminum components. They are usually anchored to the ground by short piles. For the last decade, damage caused by natural disasters, mainly caused by strong wind during typhoons, has been reported many times. Some reports have described frame damaged caused by piles pulled out by wind loads, even though wind speeds recorded at corresponding areas did not reach the designed wind speed. Because photovoltaic power plants sometimes extend beyond a few hectares, conducting ground explorations to avoid foundation defects completely is onerous. Moreover, a solar panel mounting structures generally have no structural redundancy, especially in the out-of-plane direction of mounted panels. To explore failure mechanisms of a solar panel mounting structure with foundation defects and possible measures, a series of pressure loading tests were conducted at actual scale for a solar panel frame with 20 modules spreading about 4 m × 8 m. Although the mounting frame with no foundation defect sustained pressure of 2500 Pa with minor damage, which was two times greater than the design wind pressure of 1333 Pa, the cover glass of one module was broken at pressure lower than 800 Pa when part of a frame was lifted because of a foundation defect.

Keywords: solar panel mounting structure, pressure loading test, foundation defect, wind resisting performance

Survey, Mapping and Geoinformatics Session

3D Model Reconstruction from 3D Point Clouds Generated from Digital Images

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Abstract. BIM applications, traffic control, surface management with visualization, and the restoration of historic structures all need the creation of 3D models. However, laser scanning equipment with a lidar sensor is expensive, and lower-accuracy devices are cheaper than expensive ones. This research paper aims to reconstruct a 3D information model from photographic images to save money and be more flexible than traditional laser scanning in building and setting up the capture scheme and multi-time, ensuring coverage and satisfying the required error condition. Furthermore, it can build a color cloud, which is impossible with low-cost lasers, and ensure model correctness in small corners, concealed corners, and numerous noisy regions while maintaining point density. The 3D model reconstruction approach was used in this study to work with digital photos. Creating the point cloud model from the acquired images is possible using Structure from Motion. The Mesh model is then created using the Revit Architecture software based on the generated point cloud. Finally, analyze the divergence, make remarks, and applicability of the approach by comparing and contrasting the directly measurement method of the item with the point cloud model and 3D information model.

Keywords: photogrammetry, 3D models, structure from motion.

Creating Mesh Models from TLS Point Cloud for FEM Simulation: A Case Study of Bridge Wall Pier Appurtenance

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Abstract. Inspection and evaluation of transport works have been immensely considering in recent years. The basic important technical characteristics to evaluate the health of the bridge such as: 1) Material quality: test elastic moduld, poison coefficient, strength... 2) Integrity of the structural surface: defects, breaking, changing shape,...3) Working capacity of the structure: flexural-tensile capacity, structural stability,... Previously, the collection of structural data was carried out manually such as: measuring, redrawing the current status of the works against the design documents, etc. In recent decades, point cloud data has been obtained in many ways such as: Camera, MLS, UAV… used to build realistic 3D models, detailing texture shapes. From this model, the mesh is created for the evaluation of the surface integrity and working capacity of the structure. In this study, Terrestrial Laser Scanner (TLS) was used to collect data of bridge wall pier appurtenace. The expected result is that the 3D model is created into different file formats compatible with current software, thereby serving the finite element simulation model to evaluate the durability of the structure.

Keywords: teresstrial laser scaning, computational modeling, 3D model generation

Exploring the Impact of Covid-19 on Air Quality Using Sentinel-5p and Modis Data in Ho Chi Minh City

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Abstract: The Corona virus disease in 2019 (Covid-19) has come up with serious consequences in public health all over the world, and especially in Ho Chi Minh City (HCMC). During the pandemic, the city needs to do quarantine activities to control the spread of the virus. This study focuses on exploring the impact of the Covid-19 outbreaks on the air quality by the concentration of pollutants including Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2), and Ozone (O_3) derived from Sentinel-5P TROPOMI data, and Particulate matter under 2.5 mm of diameter ($PM_{2.5}$) estimated from MODIS Aerosol Optical Depth (AOD) data. The duration of the research is from 1st January 2020 to 31st December 2022, and separated into 2 parts, based on the dry season and the wet season for the case study of Ho Chi Minh city. As a result, it shows the decrease in different level of air pollutants, including the significant decline in NO_2 (up to 15.27%), SO_2 (up to 46%), and $PM_{2.5}$ (up to 25.46%), while the O_3 layer suffered minor change of 1.75% in increasing. The results are expected to provide an understanding of the geospatial distribution of the air pollutants before and after the Covid-19 lockdown periods in HCMC. Moreover, it also confirms that deploying air quality monitoring systems with ground stations and satellite observations is effective.

Keywords: air quality, TROPOMI, MODIS, covid-19

Generating Time-Series Crop Surface Models from Data Acquired by a UAV-Based Laser Scanner System

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Abstract. This study introduces a method for establishing a crop surface model using laser scanning technology from the integrated Velodyne VLP-16 scanner and DJI MATRICE M600 drone. The study also provides a process to create a 3D point cloud from the raw dataset. The point clouds are used to estimate plant height based on percentile analysis. The advantage of the proposed method is that the rice plant height is estimated without pre-determining the ground position. The 99th percentile rank is a suitable value to represent the ground position. The estimated plant height correlates with the directly measured plant height, specifically for areas within 100 to 200 of the field of view. The results are achieved with a coefficient of determination greater than 0.90 and an RMSE of less than 6.0 cm. Finally, time-series crop surface models are created. These models imply the change in rice plant height during the study period. The estimated growth rate is less than 1.6 cm/day, whereas the measured growth rate is less than 1.8 cm/day. This result confirms the ability to check the rice growth rate from the point cloud collected by the developed system.

Keywords: CSM, plant height, laser scanner.

Impact on Tectonic Motion Velocities of Some Vietnam CORSs Computed from PPP Coordinates when Using IGS and CNES Products

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Abstract. Precise point positioning method (PPP) is increasingly popular in determining crustal displacement. The PPP should have precise products of the GNSS satellite orbit and clock correction. Currently there are several different Analysis Centers (AC) that offer this product such as the Center for Orbit Determination in Europe (CODE), the Center National d'Etudes Spatiales (CNES), the International GNSS Service (IGS). In principle, PPP using different products will give different positioning results. To calculate the tectonic motion velocity of some continuously operating reference stations (CORSs) in Vietnam in the period of 2019-2021, we use a precise point positioning method with 2 different products of IGS and CNES. The RMS of coordinate deviation between the two options is (3.2, 5.7, 9.1) mm in the North, East, and Up components. However, when calculating the velocity of the North component, the value of CNES is always about 2/3 smaller than IGS. While the difference in velocity of the East and Up components is within the allowable limits. Through comparison, the calculation results of tectonic velocities from IGS are more consistent with the results of previous studies despite different data sources and processing methods.

Keywords: PPP, IGS product, CNES product, tectonic plate velocity.

Integrating Thematic Map and Ecosystem Services in Evaluating the Effectiveness of District-Level Land Use Master Plans

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Abstract: Ecosystem services (ES) are understood as all the benefits that people can receive from the ecosystem. The Law on Planning 2017 clearly states: "The spatial distribution of development in the planning process must ensure consistency between infrastructure, land allocation and environmental protection, ecosystem services". District-level land use planning is one of 38 types of detailed planning. In order to provide an visual, unified and comprehensive view of the change in human benefits due to the impact of the land use master plan, the difference between the values of ecosystem services needs to be assessed and shown into thematic maps. The typical research object in this paper is the approved land use master plan of Tanh Linh district, Binh Thuan province. The main contents of the article include: (1) An overview of the selected district-level land use master plan; (2) Valuing the change in the value of ecosystem services due to the impact of the master plan by the benefit transfer method, using the Ecosystem Services Valuation Database (ESVD); (3) Selecting the optimal method and making thematic maps showing the valuation results.

Keywords: land use planning, ecosystem service, thematic map, ecosystem services valuation database (ESVD), effectiveness.

Urban Expansion in Ho Chi Minh City Detected from Landsat Satellite Images

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Abstract: Ho Chi Minh City (HCMC) is one of the largest cities in Vietnam in terms of economic and social development, with a densely populated population. Over the past four decades, the city's urban space has expanded enormously. Urban expansion has a great impact on the city's environment and infrastructure. This study focuses on exploiting Landsat satellite images from 1979 to 2022 every 5 years to reveal the urban expansion of HCMC. Firstly, the city's land cover layers are extracted from Landsat multi-spectral images using the Random Forest Classifier. The land cover layer presents its four types of impervious surface (e.g. buildings, streets, etc.), bare-soil, vegetation, and water. Secondly, the urban areas are determined from the land cover layer using the spatial filtering technique with a 15x15 pixel window in which pixels are labelled as an urban area if the window contains 70% of the impervious surface area. As a result, the area of impervious surface increases from 108.8 km^2 in 1979 to 682.9 km^2 in 2022, occupying from 5% to 32% of the city's total area. Moreover, the city was expanded from the center and its main development is obviously to the East during the observed period, and additionally there are two secondary directions to the Northwest and to the South since 2010. The results are expected to provide useful information for urban environmental planning and management.

Keywords: urban expansion, random forest, spatial filtering, landsat, Ho Chi Minh city.

Transportation Session

An Analysis on Urban Sprawl in Ho Chi Minh City and the Consequent Growth Trap for Bus Services

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Abstract. Urban sprawl refers to the phenomenon where urban areas expand rapidly into previously undeveloped land. This study implemented an analysis of aerial images to examine the progression of residential built-up land expansion in the core area of Ho Chi Minh City. The analysis revealed that between 1985 and 2020, the built-up area of the urban core expanded approximately 15.75 times, while the population experienced an annual growth rate of around 2.7%. This population growth was mainly attributed to the displacement of populations from other localities. Consequently, the urban sprawl index of the city increased from 7.38 km square/mil in 1985 to 49.07 km square/mil in 2020, representing an approximate six-fold increase. As a result, the bus service in HCMC faces a double challenge: it is difficult to attract more users from cars and motorcycles due to unfair competitive conditions, and the fact that people live far and scattered from the city center exacerbates this situation. The only viable solution for the growth of the bus service is to restructure and replan the urban areas, creating more concentric densities to minimize urban sprawl.

Keywords: urban sprawl, growth trap, dependency on private modes, bus quality of service.

A Study on the Impacts of Right-Turn Flows on Capacity of Motorcycle Lanes at 3-Leg Intersections

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Abstract. This study utilized traffic flow microsimulation assimilation to gather information about the traffic conditions adjacent to the right-turn links of 3-leg intersections. To determine the flow states of the main roads in the vicinity of the right turn lane from local roads or alleys, VISSIM micro-simulation models were employed. The study considered different cases of turning path radii and built flow-density relationship curves to evaluate the effect of different levels of intrusion of the branch flow into the main road on motorcycle capacity. According to the research, a mid-block motorcycle lane can have a theoretical capacity of 8,963 vehicles per hour. Based on the study, it is recommended that: 1) If right turn volume reaches about 1,000 MCU/hour, vehicles should follow the curb radius of R8m; 2) If turning traffic is within 600 MCU/hour, it is acceptable for vehicles from the branch road to encroach onto the main road by only 0.875-2.625m; 3) Road marking of lane lines should be used to prevent right turn vehicles from encroaching further into the main road, particularly at intersections with right turn traffic exceeding 300 MCU/hour; 4) If turning volume is over 1,000 MCU/hour, dedicated right turn lanes should be built.

Keywords: assimilation of traffic flow simulation, capacity, motorcycle, right turn link, mixed traffic.

Analysis of the Reasons why People in Ho Chi Minh City Rarely Use Buses by Binary Logistic Regression Model

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Abstract. In the process of promoting the use of public transport in Ho Chi Minh City, buses played a leading part in the public transport system. However, in recent years, the number of passengers using the bus has tended to decrease. The aim of the paper is to use the Binary Logistic Regression Model to analyze the reasons why people in Ho Chi Minh City rarely use buses. This article uses the survey data set of the Ho Chi Minh City Department of Transport interviewed households in 24 districts and people at 9 transport hubs in Ho Chi Minh City in 2017. The results indicate that the factors affecting the bus use include owning personal vehicles such as motorbikes and cars, individuals with higher incomes also use less buses, women have a greater need to use the bus than men, and the time to leave work and the distance to the bus stop also have an impact on the bus choice decision. Proposals were made including improving the quality of traffic on the road, reclaiming the operating hours and routes of bus routes when passing through the central area and more propaganda about the law and behavior. When participating in traffic, ensure the quality of bus service through improving the quality of operation, the behavior of drivers and service staff, ensuring the security system and modern equipment on buses, arrange more bus stations or add necessary branch lines to gather more passengers.

Keywords: public transport, binary logistic regression analysis, service quality, bus user, private vehicles.

A Review of Activity-Based Models, Focusing on Travel Demand Modeling for Developing Countries

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Abstract. Activity-based modeling is the latest trend in urban travel demand forecasting. Activity-based models based discrete choice model system of an individual's daily activity and travel schedule. The model system represents an individual's choice of travel activities as a hierarchical structure of multiple choices in the form of several patterns and a set of tours. This paper summarizes recent results and limitations of using activity-based approaches in travel demand forecasting, with a focus on developing countries. On top of that, essential applications of this approach for assessment and evaluation in transportation planning are provided. Finally, some directions are highlighted for the future development of activity-based analysis.

Keywords: activity-based model, urban travel demand forecasting, discrete choice model, hierarchical structure, transportation planning evaluation.

Differences in Personality Characteristics, Demographics, and the Predictive Value of the Self-Reported Speeding Behavior Model of Young Riders in Vietnam

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Abstract. This study aimed to examine the differences in speeding behavior for personality traits (sensation-seeking, anxiety, anger, altruism, normlessness) and demographics (gender, age, riding experience, geographical areas) of young riders. In addition, it aimed to test speeding behavior using the Theory of Planned Behavior (TPB). Based on 222 complete and valid responses, the reliability and validity of the data for each question was evaluated. Data were analyzed by Analysis of Variance (ANOVA) to test for differences in personality and demographics. Structural equation modeling (SEM) was also performed to determine the speeding behavior. The results of the ANOVA analysis show that there is a significant difference in the speeding behavior toward personality characteristics and demographics. The results of SEM analysis show that attitude towards speeding behavior has a strong indirect influence on speeding behavior through behavioral intentions, and the subjective norm has a weak indirect positive influence on speeding behavior through behavioral intention. Perceived behavioral control also, directly and indirectly, has a weakly positive influence on speeding behavior through behavioral intention. Research results can help design more effective safety and intervention campaigns, such as focusing on awareness education on driver personality, gender, driving experience, geographical areas, etc. On the other hand, the SEM model results show that it is necessary to change the attitude of the riders towards this violation, correcting the social norms, improving their safety awareness, etc., to reduce speeding behavior.

Keywords: speeding behavior, personality, demographics, theory of planned behavior, risky rider behaviors.

Factors Affecting the Decision to Use Bicycle Share: A Case Study of Students in Vietnam National University Ho Chi Minh

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Abstract. Public bus transportation is available in the Vietnam National University Ho Chi Minh City (VNU-HCM), but mainly for students traveling from outside of the university to VNU-HCM. A bus system is unsuitable and not so flexible for trips inside universities with short lengths of only 1-2km. With convenience and high mobility of bicycles, bicycle share is currently applied in some universities around the world. We proposed a bicycle-sharing system in VNU-HCM and introduced some of its basic characteristics. A survey with stated preferences method was conducted to collect information of potential students about the proposed system. Then we analyzed factors affecting the VNU students' decision to use bicycles based on binary logistic regression. Finally, solutions are also suggested to improve the probability that students will use bicycle share.

Keywords: public transportation, bicycle-sharing system, stated preference, binary logistic regression.

Revisiting Features Used in Forecasting the Conditions of Bridge Components

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Abstract. This study explored features that potentially effects the conditions of bridge components such as decks, substructures and superstructures. The study utilized the 2022 National Bridge Inventory (NBI) data and Moderation Analysis (MA) to investigate the features. The study first assessed 24 features used in previous studies for forecasting bridge component conditions. MA was then used to confirm the effects of these features on bridge component conditions. The current study further identified additional 28 features. The combined 52 proposed features were finally divided into four groups, including Geographic Region (A), Bridge Other Attributes (B), Structure Configuration (C), and Condition Rating (D). The identification of these features is the first and important step for forecasting bridge component conditions.

Keywords: bridge, condition rating, prediction, deck, substructure, superstructure.

Application of Hot Mix Asphalt Containing Industrial Coal Waste in Road Pavement Based on Vietnamese Specification

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Abstract. The application of waste products from industrial parks into construction is one of the study and application trends that concerned by many researchers and engineers these days. Coal ash from industrial parks is and is going to cause problems in environment as well as high prices in treatment. Most of the studies focus on cement concrete using coal ash as fly ash or bottom ash. Some studies applied industrial coal waste in asphalt concrete, but the evaluated test is simple tests such as Marshall stability, flow, and indirect tensile strength test. As a result, the paper focuses on using coal ash from furnace products in industrial parks in dense-graded asphalt concrete based on laboratory tests, including the indirect tensile fatigue, surface friction, and wheel tracking test. The sand patch method is used to evaluate the macro-texture depth of asphalt concrete surfaces using coal ash incorporated fine mineral aggregate, which is very important for road safety driving.

Keywords: asphalt concrete, coal ash, asphalt concrete, indirect tensile fatigue, sand patch, wheel tracking.

Study on Adhesive Characteristics of RFCC Asphalt Mastic

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Abstract. The subject of the investigation is the adhesive qualities of asphalt mastic produced by residue fluid catalytic cracking (RFCC). Recycling RFCC, industrial waste from refineries, in asphalt mastic may change the adherence of the asphalt binder. This study investigates RFCC filler affecting the bonding interface between asphalt mastic and smooth solid surface and aggregates. The adhesive properties of RFCC asphalt mastic were investigated through various laboratory tests, including an adhesion test according to TCVN 7504:2005, a modified pull-off test, and the Vialit plate shock test. The article uses experimental data to compare the adhesion properties of RFCC asphalt mastic to conventional fillers like limestone and Portland cement. The results show that RFCC asphalt mastic exhibits good adhesive properties under various surface roughness.

Keywords: adhesion, asphalt mastic, RFCC, filler.

Survey of Vibrational Characteristics of Bridge Span by Viscoelastic Material Model

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Abstract. From the viewpoint that a structure is deteriorated by virtue of the mechanical change of the material. This study has applied the viscoelastic model to the problem of identifying vibration in the structure. The viscoelastic model describes the material's mechanical properties by two mechanical parameters consisting of the elastic modulus and the viscous coefficient. Therefore, this study extracts parameters from vibration measurement signals to identify vibration parameter changes and their relationship with mechanical parameters. The addition of mechanical and vibration parameters for the system identification brings a lot of efficiencies. Alternatively, the results of this study are based on an experimental survey from a bridge in Ho Chi Minh City, Vietnam. Accordingly, this study will be the basis for forecasting the condition of the structure.

Keywords: viscoelastic model, vibration, bridge span, energy loss.

Water Resource and Hydraulic Session

An Analysis of Seepage Mechanism Through Embankment Dams Based on the Assumption of the Uncertainties of Soil Permeabilities

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Abstract. This study is an attempt to investigate the unconfined steady-state seepage through embankment dams using finite element method. The implementation is made employing a programming language (Python), which includes the random generation of soil permeabilities within the region of interest. Besides, the seepage also incorporates the effect of unsaturation into permeability using van Genuchten's theory. Next, Monte-Carlo simulations are conducted to examine the aspects such as the relationship of the number of samples and the outcomes, statistical inferences of flowrates, exit gradient, positions of free surfaces within dam body.

Keywords: seepage, embankments, finite-element modelling, uncertainty.

An Application of ANN on Groundwater Level Prediction of the Fractured Aquifers in the Nhue - Day River Basin

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Abstract. Groundwater level (GWL) varies periodically or non-periodically with various factors including rainfall (RF), evapotranspiration (ET), number of sunny hours (NS), humidity (HM), air temperature (AT), and topographic elevation (TE). This study presents an implementation of an Artificial Neural Network (ANN) to predict groundwater level in the fractured aquifers of Nhue - Day river basin, Vietnam. In this regard, the monthly historical time series climatological data (rainfall, temperature, humidity, and evaporation) during 2018–2019 and hydrogeological parameters at seven observation wells have been used as input variables to estimate GWL. The developed Levenberg-Marquardt back-propagation ANN models were compared through statistical performance criteria: Mean Square Error (MSE), Mean Absolute Error (MAE), and Coefficient of determination (R). Results showed that the ANN model predicted groundwater level with reasonable errors. The average root mean square prediction error was 1.77 m for groundwater level prediction at seven observation wells. The training results revealed that monthly precipitation and evaporation are important variables that have a strong influence on groundwater level prediction. Based on these values, the seasonal groundwater level and fluctuation were mapped using the geostatistical toolbox in ArcGIS 10.8. Finally, the present study as a pioneer approach provides significant contributions to groundwater management and development of Nhue - Day river basin.

Keywords: ANN, groundwater level, fractured aquifer, Nhue-Day river basin.

Assessing Ho Chi Minh City Apartment Water Demand Criteria

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Abstract. The examination of water demand norms in various residential construction types in Ho Chi Minh City is shown in this research. The study methodology includes examining water usage of each apartment as well as assessing the unique characteristics of each structure. Survey data on water demand has been collected in 20 apartments of four distinct types: the average apartment without a swimming pool, the average apartment with a swimming pool, the high-level flats with swimming pools, and the luxury apartments with swimming pools. The findings indicate that the average water supply demand per person steadily rises with the type of apartment: 166.1 liters per person per day - night; 169.4 liters per person per day - night; 172.7 liters per person per day - night; and 183.4 liters per person per day - night. The equivalent rise rates are 1.92%, 3.81%, and 9.41% when comparing the percentage increase to the lowest-grade apartment type. The findings could be used to evaluate the water supply requirements for high-rise residential projects in the Ho Chi Minh City region.

Keywords: water demand, apartment, building.

Assessing the Environmental Impacts of the Artificial Navigation Channel in Southern Vietnam

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Abstract. The new Hau's entrance navigation route (known as "bypass project") has been kicked-off in Tra Vinh province with aim to increase the availability of waterway traffic in the Mekong delta. The improvement project includes with existing Quan Chanh Bo channel and 8 km of artificial channel was 1st launched in 2017. After years of operation, the project has taken its effects on the movement of the large cargo vessel to the inland ports. However, with immense biological risks identified, riverbank erosion coupled with the risk of deposition has raised questions to governments and scientists about its viability. This paper analyses the environmental impacts of the navigation channel in context of bank stability and sedimentation discharge. It was shown that, digging of new canal has significantly affected the current velocity at the river mouths. It is also found that, increasing of the movement through navigation channel is expected to increase the risk of bank erosion and sediment deposition in simulated volume of sediment discharged is 691.483 m^3/year.

Keywords: bypass project, artificial canal, ship-generated wave, bank erosion, sediment transport.

Evaluation of Microplastic Removal Efficiency at Wastewater Treatment Plant of A Kraft Paper Factory in Vietnam

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Abstract. Wastewater treatment plants (WWTPs) are one of the critical sinks and sources of microplastics in the environment. In Vietnam, most of the previous studies were conducted at combined treatment plants (industrial and domestic) as well as centralized plants at industrial zones, but microplastic data from solely industrial wastewater or sludge were rare. Wastewater from the recycled paper industry contains a lot of plastic waste, with the potential to have high concentrations of microplastics. Therefore, this study aims to evaluate microplastic pollution load and investigate microplastic removal efficiency of the paper mill wastewater treatment plant. WWTP of the Kraft paper factory A, using primary treatment facilities, level I (Dissolved Air Flotation-DAF), level II (Upflow Anaerobic Sludge Banket-UASB and Conventional Activated Sludge-CAS) and level III (DAF and Fenton), with a capacity of 24,000 $m^3\,day^{-1}$ was selected for the survey. The results show that the microplastic load of this factory was up to 126,759,680 items day^{-1}, although the removal efficiency was 99.8% and the concentration of microplastics in treated wastewater was 12 items m^{-3}. The primary and secondary treatment process removed microplastics with highest efficiency, 75.8% – 97.9%, especially DAF had a microplastic removal efficiency of >95%. Microplastic concentration in sludge sample was 22,772 items kg^{-1} of dry weight. For morphologies, microplastics in paper mill and sludge samples existed solely in the form of fibers (55% and 91%) and fragments (44% and 9%), respectively, and blue and white microplastics accounted for 37% and 30% of the total.

Keywords: microplastics, Kraft paper factory, activated sludge, microplastic removal efficiency

Evaluation of Sea Level Rise Influence on Tidal Energy in the Coastal Area of Ho Chi Minh City, Vietnam

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Abstract. Ho Chi Minh City, located in the key economic zone in Vietnam, is one of the ten cities in the world that is threatened by the risks due to high sea level rise. In the study, the tidal energy change of 4 main tidal constituents (K_1, O_1, M_2, and S_2) in the coastal area of Ho Chi Minh City under the influence of sea-level rise is investigated by the numerical model in the curvilinear coordinate system. The tidal energy simulation results show an upward trend in total and potential energy, whereas the kinetic energy decrease in both the 2050 and 2100 forecast scenarios. In 2050, the maximum total energy of M_2 constituent is $1{,}915 \times 10^9$ KJ, an increase of $0{,}083 \times 10^9$ KJ compare to 2020. In 2100, this energy reach $2{,}009 \times 10^9$ KJ, a rise of $0{,}177 \times 10^9$ KJ compare to 2020. The kinetic energy component drops by $0{,}032 \times 10^9$ KJ in 2050 and $0{,}067 \times 10^9$ KJ in 2100 compared to 2020. In contrast, the potential energy component rise by $0{,}115 \times 10^9$ KJ and by $0{,}244 \times 10^9$ KJ in 2050 and 2100, respectively. The result is the premise for the future potential assessment of renewable energy in the sea area of Ho Chi Minh City.

Keywords: tidal energy, Ho Chi Minh city, Sea Level rise, the curvilinear coordinate system, the numerical model.

Impact of Soil Type in Strategy for Green Infrastructure Planning as Nature-Based Solutions to Mitigate Urban Flash Flood

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Abstract. Due to the growing socio-economic and rapid urbanization, urban flooding has become more frequent and severe, especially in developing cities. Despite the urban green infrastructures being well-known as effective nature base solutions in alleviating stormwater runoff, there is comparatively little research for planners and designers to adapt proper soil type to enhance flooding mitigation via urban green space. This study explores the soil type on the strategy for green infrastructure planning as nature-based solutions to mitigate urban flooding. First, the study measures the infiltration and soil classification of seven field sites in green urban in Thu Duc City. Second, the initial abstraction and the poinding time were estimated by overlaying between rainfall hyetograph and infiltration rate curves. The results can show soil type's impact on green infrastructure planning strategy as nature-based solutions to mitigate urban flooding. The soil with less than 10% clay content is proper for green infrastructure to enhance stormwater runoff reduction and groundwater recharge.

Keywords: Green infrastructure planning, nature-based solutions, soil type, Thu Duc city.

Impacts of Upstream Reservoirs on Flow Pattern Changes at the Kratie Hydrological Station, Mekong River Basin

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Abstract. This study used the innovative trend analysis method, the Pettitt test, and reservoir development data to evaluate the effects of upstream reservoir development on changes in the flow regime at the Kratie hydrological station, located in Phom Penh, Cambodia, which is the outflow of the Mekong basin (MKD) before it flows into the Mekong delta (MKD). The Pettitt test detected that the mean water level time series changed their statistical characteristics in 1994 and the minimum, maximum water level time series changed their statistical characteristics in 1999. The change point occurred sooner to compared with the dam boom time in 2010. From 1973 to 2018, the minimum and mean water level increased by 3.95 cm/yr and 2.16 cm/yr, respectively, and the maximum water level slightly decreased by -0.04 cm/yr. In the subperiod from 2000 to 2022, the minimum water level trend in increased slower than the full period from 1973 to 2022 and the maximum water level decreased slower than the full period from 1973 to 2022. The result showed that the driest time shifted one month sooner to compared with the pre-dam period.

Keywords: flow pattern change, kratie, innovative trend analysis, mekong river basin, pettitt test.

Influence of Grain Size on the Sediment Budget for Nourished Sand Bars in Hoi-An Area

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Abstract. The phenomenon of deposition and erosion on Hoi An beach in recent years has been the research topic of many organizations and researchers. Many solutions have been proposed to mitigate the erosion and one of the selected solutions for coastal protection is the nourished sand bars. This approach has the benefit of preserving the natural scenery of the tourist beach, as a certain amount of sand needs to be added each year to maintain shore protection against the waves and winds prevalent in the area. The size of the sand grains plays a critical role in the efficacy of the sand trap. This research employs the Telemac numerical model, which integrates problem-solving with hydrodynamics and coastal wave calculations, to quantitatively analyze the impact of sand grain size on the time-average expected sand deposition under various scenarios. The simulation results indicate an inverse correlation between the average diameter of sand grain size and the required amount of additional sand, as well as the effect of extreme weather conditions such as increased waves and wind on the amount of sand needed for nourished sand bars.

Keywords: coastal deposition, coastal erosion, grain size, hydrological characteristic, nourished sand bars.

Model Development of Water Depth for Spilling-Type Breaking Waves Using Gene Expression Programming

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Abstract. Breaking wave is an important phenomenon in beach deformation study and design of coastal structures. The water depth of breaking wave for spilling wave type is one of parameters affecting breaking wave needed to be investigated. Although many models are proposed for predicting breaker depth, none of them is clearly specified to apply to any particular breaker type. This paper, therefore, focuses on developing a formula for estimating the water depth of spilling-type breaking waves by Gene Expression programming. Many laboratory data covering a wide range of wave and beach conditions from small-scale and large-scale experiments are collected for model development. The results display that model developed by Gene Expression programming shows good performance with low root mean square relative error in predicting breaker depth. Besides, this model form is simple and convenient for computation. With excellent results, the developed model is strongly recommended for estimating the breaking water depth of spilling waves.

Keywords: breaking wave, gene expression programming, spilling-type breaking wave, water depth.

Telemac3d Application Simulates the Spread of Submerged Mud Off the Coast of Son Tra Peninsula, Exploited from Dredging Ship Locks at Tho Quang Fishing Port, Da Nang Province

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Abstract: In Vietnam, there is a rising demand to set up areas for the sludge waste from harbor dredging projects. The coastal regions, where ecological and environmental standards are met, are one possible place for deployment. Assessment of the submerged sludge spread enables one to determine if, if any, the concentration of suspended sludge within the bounds of the ecological zones to be protected may have an impact on nearby regions that need to be protected. The findings indicate that the tidal current's effect on the spread of sludge is quite significant. Without impacting the biological region that has to be preserved surrounding Son Tra peninsula, the research applies to the dredging mud removed from Tho Quang fishing port in Da Nang at the suggested offshore location. The submerged mud, which has a concentration of 5 mg/l, can extend up to 10 km from the discharge center when subjected to tidal currents. The research made use of the Telemac3D numerical model, which combined addressing the issue of wave propagation in the coastal region of Tomawac with solving the issue of mud propagation in the form of diffusion and convection.

Keywords: telemac3d, tomawac, hydrodynamics, mud propagation, da nang coast.

Re-Calibrating of Dissipation Models for Breaking Wave Based on Parametric Wave Approach Using Root-Mean-Square Height and Mean Wave Height

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Abstract. Wave height transformation plays a crucial role in the investigation of beach deformation and coastal structure design. Parametric wave approach is a widely used method for calculating the transformation of root-mean-square wave height only. The accuracy of existing models depends on wave and beach conditions. Due to the advantage and computational efficiency of parametric wave approach, it would be useful if this method could also be used for modeling mean wave height transformation. This paper focuses on improving the accuracy of existing parametric wave models in modeling root-mean-square wave height transformation under a wide range of wave and beach conditions. Additionally, the paper also explores the applicability of the parametric wave approach in predicting mean wave height transformation by recalibrating coefficients of existing models. Seven parametric wave models are examined and calibrated using both laboratory and field data to predict both root-mean-square and mean wave height transformation. The findings of the study show that the accuracy of root-mean-square wave height transformation prediction is enhanced after modifying coefficients. Furthermore, the paper demonstrates that the parametric wave approach can be effectively employed to predict mean wave height transformation. With adjusted coefficients, parametric wave models estimate mean wave height with great accuracy.

Keywords: parametric wave approach, root-mean-square wave height, mean wave height, energy dissipation, wave height transformation.

Sliding Mode Controller Design for Active Magnetic Bearings of A Flywheel Energy Storage System Used in High-Rise Building

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Abstract. In this paper, we will build the benefits of the electromechanical storage of energy over long operating cycles within the scope of decentralized electrical energy production. A dual-direction motor/generator contributes or generates electrical energy that can be utilized in the high-rise building. To keep it at a in height effectiveness, the flywheel runs within a vacuum chamber. Active magnetic bearings (AMB) make use of magnetic force to establish rotor's rotating shaft free of mechanical abrasion. This work advances a mathematical model of the levitation force and rotational force of a flywheel. The scheme for governing the position of the flywheel is constructed based on a sliding mode controller. The simulations have been carried out to portion the dynamic retort of the rotor to a straight disturbance. The results reveal that the sliding mode controller offers good performance.

Keywords: flywheel energy storage system, sliding mode observer, apartment building, sliding mode control.

Study on Recharge of Groundwater in the Sand Dunes Area South of Luy River, Binh Thuan Province

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Abstract. Groundwater resources play an important role in water supply in the dry season in Binh Thuan province. Accurate assessment of groundwater recharge makes an important contribution to the protection and rational use of groundwater resources for this province. Especially in the sand dunes, it acts as a water reserve in the dry season for the foothills. During the rainy season, rainwater soaks into the sand and then seeps out at the foothills in the dry season. Due to the large permeability coefficient, rainwater easily replenishes into the unpressurized aquifer and recharges groundwater. In this paper, the process of groundwater recharge in the sand dunes area of the Southen of Luy River, Binh Thuan province has been simulated by a numerical model. The mathematical model is built with 3 sub-models integrated together. Which, is the horizontal 2D model for the surface overflow, the vertical 1D soil column model for the groundwater flow in the unsaturated zone, and the horizontal 2D model for the groundwater flow in the saturated zone. Calculation results have shown the replenishment rate of rainwater. In addition, the calculations have also clarified the phase delay of groundwater flow compared to the rainy season.

Keywords: Sand dune, Luy river, groundwater recharge, numerical simulation.

Combining 1D, 2D, and 3D Models to Create An Efficient Tool to Simulate Bed Change of The Hau River in Chau Phu District, An Giang Province

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Abstract. Using integrated models is now a trend in hydraulic and sediment transport simulation. Models can be integrated from 1D, 2D, and 3D submodels. The 1D model allows calculating the average velocity and suspended sediment concentration on cross-section and profile's averaged erosion or accretion behavior of riverbed. Meanwhile, the 2D model calculates the depth-averaged velocity and suspended sediment concentration, a mean that allows detailed calculation for each point on the plane. The 3D model is the most detailed. The model calculates the velocity and suspended sediment concentration at each point in 3D space and thus it is capable of simulating the secondary structures of the flow as well as the influence of these structures on sediment transportation. With 2D and 3D models, bed change is calculated for each point. However, the more detailed the model will require more computer resources as well as running time, so it is not suitable for large-scale problems. Combining 1D, 2D, and 3D submodels together will allow the creation of an efficient model that can both carry out large-scale problems and allow detailed calculations of areas of special interest. Besides, the model also solves the problem of boundary conditions of detailed models. In this paper, a 1D2D3D integrated model that calculates and simulates the bed evolution of the Hau river section flowing through the Chau Phu district is introduced. Methods of calculation and integration of submodels are presented. The simulation results show that the model reflects quite well the reality of the river section.

Keywords: 1D2D3D integrated model, sediment transport, bed change, Hau river.

Suitable Irrigation Schedule for Urban Green Space Via Soil Moisture Sensor and Modeling

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Abstract. Under rising populations, urbanization growth, and water scarcity pressures, water conservation of urban green space is critical for governments and town planners. Nevertheless, traditional irrigation scheduling based on farmer expertise becomes outmoded and wastes water resources. Proper irrigation scheduling is essential for sustainable green urban development, as it decreases the water consumption of green spaces and lowers labor costs without leading to plant stress. This study aims to determine a suitable irrigation schedule for urban green space via soil moisture sensors and modeling. Initially, a resistivity sensor was employed to measure soil moisture. The Hydrus 1D model was then used to replicate the soil water movement. Soil moisture monitoring was used to determine the water retention parameters by reverse modeling. Thirdly, an appropriate irrigation schedule was created based on a sufficient irrigation amount and a soil moisture study. The results provide the appropriate base irrigation scheduling, which can be adapted for innovative irrigation systems.

Keywords: decreases the water consumption, hydrus 1d, suitable irrigation schedule, soil moisture sensor, urban green space.

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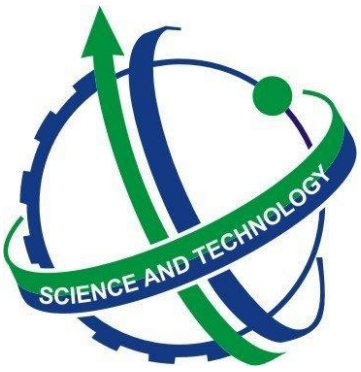
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