WE ARE THE NEXT
KOREA UNIVERSITY

2025 Future-Shaping ACE (Architectural, Civil, and Environmental Engineering) Congress

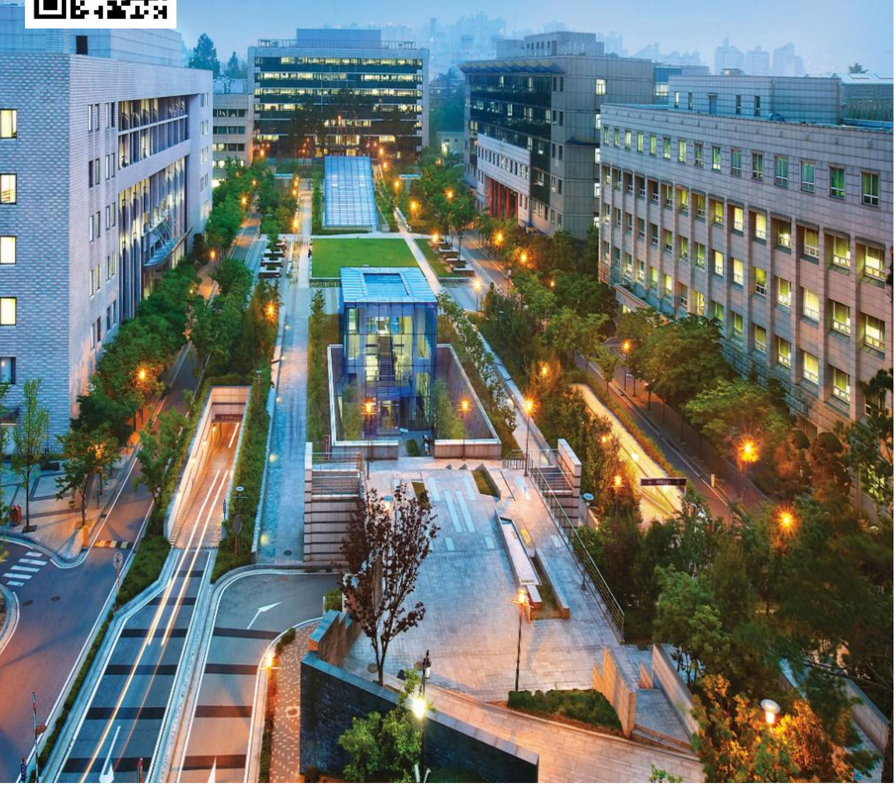
August 25-28, 2025

Location

Simultaneous online broadcasting
Selected sessions to be held face-to-face at Korea University

Zoom Link

https://korea-ac-kr.zoom.us/j/87698274777?pwd=DuTIKHJpwgLud20KONoxglnkhHrO92.1 (Password : 163977)



Organized by

4단계 BK21 건축사회환경공학교육연구단
BK21 FOUR R&E Center for Civil, Environmental and Architectural Engineering

FOUR BK21

f-ace lab
Future and Fusion Lab of Architectural, Civil and Environmental Engineering

유무기복합형 태양전지 에너지혁신연구센터
Energy Innovation Research Center for Hydrid Solar Cells

워터 리파이너리 플랫폼 자동화/모듈화 선도연구센터
Global Center for Automation and Modularization of Water Refinery Platform

Welcome Message

This year, the congress sessions are being conducted in a hybrid mode—a fusion of online and in-person meetings—fostering knowledge exchange and promoting interdisciplinary collaboration among attendees from multiple time zones. The main themes of the congress include: (i) smart mobility, (ii) built environment, (iii) eco and energy systems, and (iv) climate, water, and resilient infrastructure. We have invited both international and domestic early-career researchers, as well as academic leaders, to deliver talks highlighting recent academic achievements across seven sessions. The BK21 Four program, in partnership with the f-ace Lab, the Energy Innovation Research Center for Hybrid Solar Cells, and the Global Center for Automation and Modularization of Water Refinery Platforms, has hosted this international event. All support is sincerely appreciated.

I would like to express my profound gratitude to Prof. Chulsang Yoo for presenting his plenary lecture. Furthermore, the hard work and dedication of all committee members are

Welcome Message

deeply appreciated. Thanks to the sponsorship of Korea University in celebration of its 120th anniversary, we organized more sessions this year, allowing international researchers to present their talks in person. With the common theme of light as a driving force to induce chemical redox reactions, the in-person session on Eco and Energy Systems was jointly organized. I am confident that the congress will serve as a valuable forum to provide well-balanced learning

opportunities for student attendees from a broad spectrum of research backgrounds, while reinforcing academic exchange, the original objective of this congress. I hope you enjoy every minute of the congress lectures during this late summer in Korea. Thank you again for your continuous involvement.

Jaesang Lee

Vice-Director of BK21 FOUR R&E Center

Plenary Lecture

Water Security in the Era of Climate Change

Chulsang Yoo, Korea University

Time: Aug 25, 10:00 ~ 11:00
Location: Auditorium, Hana Square

Abstract

The definition of water security is broad. Simply put, water security refers to the reliable availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems, and production—along with an acceptable level of water-related risks. Key components of water security include availability, accessibility, quality, sustainability, and, finally, risk management. In particular, the last component, risk management, should answer the question: *"Are communities protected from floods and droughts?"* Unfortunately, climate change worsens water security by disrupting the water cycle, altering precipitation patterns, and increasing the frequency and severity of extreme weather events. This results in greater uncertainty, scarcity, and risks related to water availability, quality, and distribution. Simply put, we are experiencing more intense rainfall in some

regions, and less rainfall or prolonged dry spells in others. This means more frequent and severe floods and droughts. Additionally, we must recognize that the risk of flooding is even greater in urban areas. There are many reasons for this, but one key factor is that the design criteria—particularly the return period (or recurrence interval)—used for urban drainage systems is relatively short: typically 2 to 10 years, and at most 30 years. This is much lower compared to the return periods for small channels or local streams (10–50 years), and large rivers (100–300 years). Therefore, it is practically impossible to prevent all flooding in urban areas. However, protecting human lives remains the top priority. For this reason, radar-based rainfall observation, rainfall nowcasting/forecasting, and early warning systems are especially important in urban flood management.

About the Plenary Speaker

Chulsang Yoo attained his bachelor's and master's degree from Korea University and Ph.D. from Texas A&M University. After acquiring his Ph.D., he worked as a research associate at TEES, Texas A&M University, as a senior researcher at K-water Research Institute, and as an associate professor at Sungkyunkwan University. Currently, he is a Professor at the School of Civil, Environmental and Architectural Engineering, Korea University. He also served as the head of the department and the head of the BK21-Plus Program. His research covers broad areas of Surface Hydrology, Stochastic Hydrology and Radar Hydrology. He carried out more than 20 research projects on these topics and published more than 300 papers both in local and international journals. He has won many academic awards from Korean Society of Civil Engineers (KSCE), Korean Water Resources Association (KWRA), Korean Wetland Society (KWS), and American Society of Civil Engineers. He is now serving as the president of Korean Water Resources Association.

Presentation Schedules

Day 1 Smart Mobility (Aug 25)

Min Xu, **The Hong Kong Polytechnic University**

Transportation

Location: Auditorium, Hana Square

Chair: Sung Hoo Kim

Time	Lecture
14:00-14:30	*Meng Xu*, **Beijing Jiaotong University** A Reservation and Allocation Mechanism for Smart Parking System Considering Parking Unpunctuality
14:30-15:00	*Tarun Rambha*, **Indian Institute of Science** Optimizing Electric Bus Fleet Operations and Charging Infrastructure
15:00-15:30	*Min Xu*, **The Hong Kong Polytechnic University** Modeling and Optimization for Electric Truck Routing and Platooning
15:30-16:00	*Tao Liu*, **Southwest Jiaotong University** Human-Machine Collaborative Decision-Making Approach to Scheduling Customized Buses with Flexible Departure Times
16:00-16:30	*Prateek Bansal*, **National University of Singapore** A Data Fusion Framework to Infer Multi-Modal Time-Dependent Origin-Destination Travel Demand Matrices
	Closing remarks

Presentation Schedules

Day 2 Built Environment (Aug 26)

Structural Systems

Location: 364, Engineering Building (on-site and via Zoom)

Chair: Seungjun Kim

Time	Lecture
10:00-10:30	*Chungkuk Jin*, **Florida Institute of Technology** Recent Advances in Discrete
10:30-11:00	*Sungpil Ahn*, **Ocergy** Designing Wind Floaters: Engineering Challenges and Practical Strategies
11:00-11:30	*Hyungchul Yoon*, **Chungbuk National University** Vision-based Structural Health Monitoring of Pedestrian Suspension Bridges
11:30-12:00	*Youngjin Choi*, **Korea Institute of Ocean Science and Technology** Research Planning on the Construction of a Hyperscale Underwater Data Center
	Lunch break

Geomechanics

Location: 364, Engineering Building (on-site and via Zoom)

Chair: Abraham Bae

Time	Lecture
14:00-14:30	*Kiseok Kim*, **Texas A&M University** Effect of CO_2 Injection on the Poromechanical and Multiphase Flow Characteristics of Subsurface Rock
14:30-15:00	*Hyung-Koo Yoon*, **Daejeon University** Application of Various Investigation Techniques for Understanding the Distribution of Engineering Properties in Permafrost Ground
15:00-15:30	*Jongmuk Won*, **Ulsan National Institute of Science and Technology** Clay Particle Transport in Sand Medium: Mechanisms and Applications
15:30-16:00	*Jung-Doung Yu*, **Jeonbuk National University** Application of Electromagnetic Waves to Assess the Integrity of Geo-Infrastructures
	Closing remarks

Presentation Schedules

Day 3 Eco and Energy System (Aug 27)

Eco and Energy Systems-I

Location: Auditorium, Hana Square — Chair: Jaesang Lee

Time	Lecture
10:00~11:00	*Wonyong Choi*, **Korea Institute of Energy Technology** Engineering Photo(electro)catalytic Materials for Sustainable Environment
11:00~11:30	*Kangwoo Cho*, **Pohang University of Science and Technology** Ti-Nb Oxide Nanotube Arrays with Cathodic Engineering for Photoelectrochemical Water Treatment
	Lunch break
13:00~13:30	*Yunho Lee*, **Gwangju Institute of Science and Technology** Advancing Photochemical Technologies for Controlling Emerging Contaminants in Urban Water Systems
13:30~14:00	*Hyoung-il Kim*, **Yonsei University** (Photo)electrocatalytic Destruction of Emerging Contaminants via In-Situ Generation of Reactive Oxygen Species

Eco and Energy Systems-II

Location: Auditorium, Hana Square — Chair: Jun Hong Noh

Time	Lecture
14:20~15:00	*Sang Il Seok*, **Ulsan National Institute of Science and Technology** Integrated Strategies for High-Efficiency and Stable Perovskite Solar Cells
15:00~15:30	*Jin Young Kim*, **Seoul National University** Perovskite-based Tandem Solar Cells
15:30~16:00	*Jangwon Seo*, **Korea Advanced Institute of Science and Technology** Efficient and Stable Perovskite Solar Cells through Interface and Additive Engineering
16:00~16:30	*Jin-Wook Lee*, **Sungkyunkwan University** Reproducible Fabrication of Metal Halide Perovskite Solar Cells: From Solution to Vapor Deposition
	Closing remarks

Presentation Schedules

Day 4 Water and Resilient Infrastructure (Aug 28)

Resilient Infrastructure against Urban and Natural Disasters Location: 364, Engineering Building (on-site and via Zoom)	Chair: Donghyuk Jung
Time	Lecture
10:00~10:45	*DoSoo Moon*, **University of Hawai'I at Mānoa** Assessment of Structural Vulnerability to Tsunami Loading Considering Wave and Bathymetry
10:45~11:30	*Suyun Paul Ham*, **University of Texas** Infrastructure Monitoring: Advanced Techniques for Rapid Structure Evaluation and Sinkhole Prevention
	Lunch Break
Legacy and Leap: A Centennial Session on Urban Water Networks Location: 364, Engineering Building (on-site and via Zoom)	Chair: Donghwi Jung
Time	Lecture
14:00-14:45	*Bryan Karney*, **University of Toronto** Perspectives on Water Distribution, Energy, and Sustainability; Some Observations from North American
14:45-15:30	*Enrico Creaco*, **University of Pavia** Evolution, Recent Trends and Future Directions of European Research on Water Distribution Networks
15:30-15:40	Break
15:40-16:25	*Sanghoon Jun*, **Chungnam National University** Historical Overview and Future Challenges of Water Distribution System Research in Korea, with a Particular Focus on Korea University
	Closing remarks

Human-Machine Collaborative Decision-Making Approach to Scheduling Customized Buses with

Tao Liu

Abstract

Public transport agencies need to leverage on emerging technologies to remain competitive in a mobility landscape that is increasingly subject to disruptive mobility services ranging from ride-hailing to shared micro-mobility. Customized bus (CB) is an innovative transit system that provides advanced, personalized, and flexible demand-responsive transit service through digital travel platforms. One of the challenging tasks in planning and operating a CB system is to efficiently and practically schedule a set of CB vehicles while meeting passengers' personalized travel demands. Previous studies assume that CB passengers' preferred pickup or delivery time is within a pre-defined hard time window, which is fixed and cannot change. However, some recent studies show that introducing soft flexible time windows can further reduce operational costs. Considering soft flexible time windows, this presentation first introduces a nearest neighbor-based passenger-to-vehicle assignment algorithm to assign CB passengers to vehicles and generate the required vehicle service trips. Then, a novel bi-objective integer programming model is proposed to optimize CB operation cost (measured by fleet size) and level of service (measured by passenger departure time deviation penalty cost). Model reformulations are conducted to make the bi-objective model solvable by using commercial optimization solvers, along with a deficit function-based graphical vehicle scheduling technique. A novel two-stage human-machine collaborative optimization methodology, which makes use of both machine intelligence and human intelligence to collaboratively solve the problem, is developed to generate more practical Pareto-optimal CB scheduling results. Computational results from a real-world CB system are provided to showcase the effectiveness and advantages of the proposed optimization model and solution methodology

Tao Liu is a Professor in the School of Transportation and Logistics at Southwest Jiaotong University, China. He earned his Ph.D. degree in Civil Engineering from the University of Auckland (UoA), New Zealand. From 2017 to 2019, he served as a research fellow at the TUMCREATE research institute in Singapore. In 2021, he conducted research at the Hong Kong Polytechnic University, Hong Kong, China. His research interests include public transport planning and operations, integrated smart mobility, transport modelling, sustainable transport, and human-AI collaboration.

Optimizing Electric Bus Fleet Operations and Charging Infrastructure

Tarun Rambha

Abstract

As cities transition to electric bus fleets, planning efficient bus itineraries and charging strategies becomes increasingly critical. In this talk, we will explore decision-support tools that jointly optimize charger placement, bus-to-trip assignments (vehicle scheduling), and charging schedules to improve operating costs. Solving these problems jointly is computationally challenging. To address this, we will present an iterated local search method designed to effectively integrate long-term and short-term decisions while scaling to large numbers of trips. These models also estimate power requirements at various charging stations, offering valuable input for infrastructure planning. We will further discuss extensions to vehicle and charging scheduling models that incorporate renewable energy sources, particularly solar power. Due to the intermittent nature of renewables, our models account for seasonality in energy production, which influences additional decisions, such as the area of solar panels to install at each depot and the capacity of battery energy storage systems. This problem is formulated as a multi-scenario optimization task and solved using Benders' decomposition. We will demonstrate the effectiveness and scalability of the proposed frameworks using open-source data from multiple public transit networks across different regions.

Tarun Rambha is an Associate Professor at the Indian Institute of Science (IISc) Bengaluru in the Center for infrastructure, Transportation and Sustainable Urban Planning (CiSTUP) and the Department of Civil Engineering. He received his PhD from the University of Texas at Austin, where he worked on network equilibrium, congestion pricing, and adaptive routing in stochastic transit and traffic networks. Before joining IISc, he was also a post-doctoral researcher at Cornell University, studying hospital evacuations and evacuation demand estimation during hurricanes. He has also been a visiting faculty at the Indian School of Business (ISB) and a visiting fellow at the Technical University of Munich (TUM). His current research focuses on public and electric mobility systems, logistics, and intelligent parking solutions.

Modeling and Optimization for Electric Truck Routing and Platooning

Min Xu

Abstract

The trucking industry plays a critical role in cargo transportation. Recently, with over 100 countries announcing "carbon neutral" goal, the trucking industry faces increasing pressure to adopt environmentally sustainable practices to lower greenhouse gas emissions. Electric trucks (ETs) are one of the promising solutions to achieving carbon neutrality. In addition, the trucking industry will also be revolutionized by emerging autonomous driving technology with improved cargo transportation efficiency and reduced operation costs. Moreover, this technology enables trucks to form platoons, traveling together with short inter-vehicle distance, thereby reducing fuel consumption due to diminished aerodynamic drag. As the trucking sector transitions to electrification and automation, truck fleet operators will face new operational challenges considering the limited driving ranges and platooning potential of vehicles. In this presentation, we will talk about ET routing and platooning problems on highways. The objective is to determine the optimal truck routing/scheduling, platooning, and energy replenishment plans that minimize the total operation costs. We formulate the problems as mixed-integer programming models and propose effective customized algorithms to obtain the optimal solutions. Numerical experiments are conducted to evaluate the proposed algorithm and explore managerial insights.

Min Xu is an Associate Professor in the Department of Industrial and Systems Engineering at The Hong Kong Polytechnic University. She received her Ph.D. degree from the National University of Singapore and double bachelor's degrees in engineering and economics from Tsinghua University. Dr. Xu's research focuses on using optimization models and data analytics to design and develop operational strategies for transportation and logistics systems with emerging technology, transportation network modeling, travelers' behavior modeling, and traffic satefy analysis. Her work has been published in many influential journals and conferences in the transportation and logistics field. She currently serves on the editorial advisory boards of Transportation Research Part C, Transportation Research Part D, and Transportation Research Part E.

A Reservation and Allocation Mechanism for Smart Parking System Considering Parking Unpunctuality

Meng Xu

Abstract

To deal with the challenges caused by parking unpunctuality in current smart parking service management, a reservation and allocation mechanism is proposed. During the reservation stage, the expected service failure rates for accepted requests are calculated and a 0-1 quadratic programming model is proposed to generate a pre-matching scheme. During the allocation stage, a rolling horizon allocation approach is developed to allocate or reallocate parking spaces to accepted requests. Furthermore, we obtain the representative distributions of parking arrival and duration for weekdays and weekends using the PH distribution. The distributions of drivers' arrival and departure time deviations are learned based on parking reservation data collected in Beijing. Results demonstrate the benefits of the proposed two-stage approach by reducing the service failure rate and increasing both parking utilization rate and the platform's net profit. The distributions of parking arrival and duration are shown to influence the evaluation of the performance of the proposed two-stage approach. Additionally, the improvements in the effectiveness of operational decisions during the allocation stage are more pronounced than those observed for tactical decisions in the reservation stage, particularly as the allocation frequency increases. Managerial implications for alleviating parking unpunctuality are further proposed.

Meng Xu is currently a Professor at Beijing Jiaotong University (BJTU), and Institute Director of the Comprehensive Transportation Systems Science. The major portion of his research focuses on innovative urban mobility management, sustainable transportation system, smart city management, transport policy analysis, green transport demand management policies, modeling and analysis of transportation systems, network equilibrium models and solution algorithm development, and large-scale traffic data sets analysis. He is the author or co-author of over 200 articles in refereed journals, book chapters and proceedings, and owns over 20 patents involving emerging mobility technologies. He serves as the Associate Editor of “International journal of urban sciences (IJUS)”, “Frontiers in Future Transportation”, IEEE Intelligent Transportation Systems Society Conference (IEEE ITSC) and IEEE Intelligent Vehicles Symposium (IEEE IV). His academic opinions and comments have been disseminated by a series of Medias.

A Data Fusion Framework to Infer Multi-Modal Time-Dependent Orgin-Destination Travel Demand Matrices

Prateek Bansal

Abstract

Time-dependent origin-destination (TD-OD) matrices are essential for understanding mobility patterns and guiding adaptive transport planning, especially during disruptions. However, generating multi-modal TD-OD matrices is difficult in data-sparse environments with limited real-time data. This talk introduces *Adaptive Multi-Granularity Learning* (AdaMGL), a scalable data fusion framework that combines sparse household travel survey (HTS) data with passively collected mobility data from a single observed mode, such as transit smart cards. AdaMGL estimates mode share ratios between unobserved and observed modes by clustering OD-time pairs based on local data stability and learning mode share patterns at multiple granularities. Applied to real-world data from Seoul and Singapore, AdaMGL accurately reconstructs large-scale multi-modal OD matrices and aligns closely with location-based service data, demonstrating strong potential for estimating demand for sustainable travel modes like walking and cycling.

Prateek Bansal is a Presidential Young (Assistant) Professor at the National University of Singapore (NUS). Before joining NUS in 2022, he was a Leverhulme Trust Early Career Fellow at Imperial College London and did a Ph.D. from Cornell, an MSc from UT Austin, and a BTech from IIT Delhi. Prateek leads the Behavioural Cognitive Science Lab at NUS and is a co-principal investigator of the Adaptive Mobility module at Future Cities Laboratory (FCL), Singapore. His research group is interested in creating new methods to address challenging questions related to mobility behavior and the adoption of emerging technologies at an individual level and an urban scale. His research has led to over 70 journal articles. He also serves as the editorial board member of Transportation Research Part A: Policy and Practice and Transportation Research Part B: Methodological, among others. He is an elected board member of the International Association of Travel Behavior Research (IATBR).

Recent Advances in Discrete-Module Beam-Based Hydroelasticity Analysis

Chungkuk Jin

Abstract

Hydroelasticity analysis for very large floating structures (VLFSs) has attracted significant attention due to the growing interest in developing ocean space as a solution to land scarcity. Real or conceptual designs of VLFSs, such as floating airports, floating cities, floating bridges, and submerged floating tunnels, are envisioned to play important roles in current and future infrastructure. To evaluate the hydroelastic effects on VLFSs, the discrete-module-beam (DMB)-based hydroelasticity analysis method has been proposed. In this approach, the VLFS is discretized into multiple rigid bodies connected by beam finite elements (FEs). A multi-body solver based on 3D potential theory in the frequency domain is used. This framework has been extended to the time domain using a modified Cummins equation. In time-domain simulations, mooring lines are modeled using rod finite element theory. Previous studies have primarily focused on 1D elasticity using beam finite elements. In this study, the DMB-based hydroelasticity method is extended to incorporate 2D and 3D elasticity. Specifically, Euler–Bernoulli beam theory, a 4-node Kirchhoff-theory-based flat shell element, and MITC9 shell elements are employed to generalize the 1D elasticity formulation into 2D and 3D elastic representations. Several structural configurations are analyzed, including a box-shaped barge, a submerged floating tunnel, and a vertical cylinder.

Chungkuk Jin has been an assistant professor in the Department of Ocean Engineering and Marine Sciences at Florida Institute of Technology, USA, since August 2022. Before that, he was a research assistant professor at Texas A&M University. He received his Ph.D. degree in the Department of Ocean Engineering at Texas A&M University in 2019. Dr. Jin's research interests include studying fluid–structure interactions to address the dynamics of ocean infrastructure and renewable-energy devices; researching hydro-elasticity; and developing ocean monitoring systems. He has authored more than 100 peer-reviewed publications and has received multiple Best Paper Awards at international and regional conferences. Dr. Jin has led or contributed to over 20 funded research projects, including being awarded an Early-Career Research Fellowship from the U.S. National Academies.

Designing Wind Floaters: Engineering Challenges and Practical Strategies

Sungpil Ahn

Abstract

The design of floating platforms for offshore wind turbines is a critical enabler for the successful deployment of floating wind farms, especially in regions with deep waters and complex environmental conditions. This presentation focuses on the key engineering principles, design drivers, and technical challenges involved in the development of wind floaters. It examines the interplay between hydrodynamic performance, structural integrity, stability, and turbine compatibility, with an emphasis on real-world design constraints such as fabrication feasibility, port limitations, and local supply chain integration.

Drawing from practical experience and recent project case studies, the presentation highlights design methodologies for various floater types – including semi-submersible, spars and TLP – along with their relative advantages. Special attention is given to the Korean market, where local developers and fabricators are working to refine floater concepts that meet both global standards and regional requirements. The session aims to provide engineers, developers, and project stakeholders with technical insights and strategic considerations for designing competitive, robust and locally viable wind floaters.

Sungpil Ahn is an Engineering Manager at Ocergy and specialist in the structural analysis and design of large-scale floating structures. He holds a B.S. in Naval Architecture and Ocean Engineering at Seoul National University and an M.E. in Ocean Engineering from Texas A&M University. Mr. Ahn has over 15 years of experience as a structural engineer, having worked at Hyundai Heavy Industries and KBR. He is currently contributing his expertise at Ocergy. Throughout his career, he has been involved in numerous naval architecture and offshore oil & gas projects, focusing on the structural analysis and design of floating systems.

Vision-based Structural Health Monitoring of Pedestrian Suspension Bridges

Hyungchul Yoon

Abstract

In recent years, there has been a notable increase in the construction of long-span pedestrian suspension bridges globally. Despite their benefits, instances of catastrophic failures have highlighted the devastating impact these structures can have on society, pointing to deficiencies in current maintenance practices. This presentation introduces a novel monitoring system for pedestrian suspension bridges, leveraging computer vision and artificial intelligence (AI). This system is capable of accurately estimating both the location and magnitude of pedestrian loads and the dynamic responses of the bridges. It integrates advanced AI and computer vision techniques to enhance safety and structural integrity. The effectiveness of this system is demonstrated through results from both simulation-based and on-site validation tests, underscoring its potential to revolutionize the maintenance and monitoring of pedestrian suspension bridges.

Hyungchul Yoon is an associate professor in the School of Civil Engineering at Chungbuk National University. His research interests lie at the intersection of structural health monitoring, smart structures, disaster response, and artificial intelligence. In recent years, he has focused on vision-based structural monitoring and digital twin development for civil infrastructure. In recognition of his innovative contributions, Dr. Yoon received the Hojjat Adeli Award for Innovation in Computing in 2018 for a groundbreaking paper published in Computer-Aided Civil and Infrastructure Engineering. He earned his B.S. from Korea University, and completed his M.S. and Ph.D. at the University of Illinois at Urbana-Champaign under the supervision of Prof. Bill Spencer. He began his academic career as an Assistant Professor at Michigan Technological University from 2016 and has been serving as a faculty member at Chungbuk National University since 2018.

Research Planning on the Construction of a Hyperscale Underwater Data Center

Youngjin Choi

Abstract

With the expansion of the Artificial Intelligence industry, data centers have emerged as a new type of architectural infrastructure, evolving into critical facilities that integrate servers, networks, and various ICT systems. The recent rapid increase in the number of data centers has led to excessive energy consumption. In particular, in data centers, approximately 50% of total energy consumption is used for cooling, indicating a significantly high energy demand for thermal management. As a solution to this issue, there have been continuous efforts to utilize seawater—which maintains consistently low temperatures—for data center cooling. This research aims to establish a large-scale underwater data center cluster by leveraging the low temperature of the marine environment, thereby addressing the limitations of conventional infrastructure and alleviating equipment cooling challenges. Based on foundational technologies for subsea space platform development, a demonstration study was planned to scale and expand data center modules. To support this, a wide range of patent and technology analyses were conducted, along with expert evaluations using the Delphi method. In addition, the research included the classification of demonstration technologies and an assessment of the urgency and significance of key research and development technologies.

Youngjin Choi is a senior research scientist in the Department of Ocean Space Development and Energy Research at the Korea Institute of Ocean Science and Technology (KIOST). He received his Ph.D. in Social Infrastructure Engineering from Korea University in 2022. Dr. Choi is currently conducting various research projects focused on the development of ocean space. His representative work includes the development of technologies for creating and utilizing underwater spaces, specifically designing independent habitats and life-support systems for human occupancy in the underwater environment. He is also planning and initiating research on underwater data centers, which aim to use low-temperature seawater to cool the heat generated by servers.

Effect of CO_2 Injection on the Poromechanical and Multiphase Flow Characteristics of Subsurface Rock

Kiseok Kim

Abstract

Geologic carbon storage has a great potential in reducing the atmospheric CO_2 emission by permanently storing large volumes of carbon dioxide in reservoir formations sealed with tight rock. During injection, multi-physical processes occur, affecting the mechanical stresses, pore pressures, temperatures, and chemistry of the participating subsurface rocks and pore fluids. These processes are coupled, meaning that changes in each aspect do impact the others mutually. Thus, the interdependent factors need to be understood as a combined system. Furthermore, to avoid CO_2 leakage through the sealing layers, their poromechanical and hydraulic properties need to be thoroughly addressed.

Experimental techniques are introduced to characterize the poroviscoelastic and hydraulic behavior, including two-phase flow, with CO_2 treatment tests conducted under high-pressure conditions. Hydro-mechanical-chemical coupling constitutive model is adopted to address the chemo-poro-viscoelastic response of subsurface rock. Ultra-low permeability of the sealing formations is accurately measured in a few month-long experiments and is coupled to the mechanical and pore network characteristics of the rock. In summary, this presentation provides a comprehensive experimental work aimed at characterizing the poromechanical and hydraulic response during CO_2 injection.

Kiseok Kim is an assistant professor in the Harold Vance Department of Petroleum Engineering at Texas A&M University. Dr. Kim investigates the rock-fluid interactions to the application of geoenergy systems, leading research in his Geoenergy Systems Laboratory. Employing a multiscale experimental approach, his work aims to understand the multiphysically coupled responses of these systems under in-situ conditions. Dr. Kim received his B.S. and M.S. degrees from Korea University, followed by a Ph.D. in Civil Engineering with a focus on rock mechanics from the University of Illinois at Urbana-Champaign. After completing the postdoctoral fellowship at the University of Texas at Austin, he joined the Department of Petroleum Engineering at Texas A&M University in Fall 2023.

Application of Various Investigation Techniques for Understanding the Distribution of Engineering Properties in Permafrost Ground

Hyung-Koo Yoon

Abstract

Permafrost is predominantly distributed in polar regions and high-altitude mountainous areas. In geotechnical engineering, specialized investigation techniques suitable for frozen ground conditions are required in addition to the standard equipment typically used, in order to ensure safe infrastructure maintenance in such environments. The objective of this study is to evaluate the applicability of two widely used geotechnical investigation tools—Dynamic Cone Penetrometer (DCP) and Ground Penetrating Radar (GPR)—in polar permafrost regions. Permafrost areas present logistical challenges, as both personnel and equipment have limited access, making it difficult to assess subsurface conditions from multiple locations. To address this limitation, the study also proposes a methodology to estimate the ground conditions in untested areas using a minimal amount of data. The field investigations are conducted near the Dasan Arctic Research Station, and to validate the proposed prediction method under data-scarce conditions, it is first applied to domestic terrains. The results shows that in polar regions, the resolution of the investigation equipment is significantly affected by the thickness of the seasonally frozen layer. In contrast, the method applied to domestic sites yields high-resolution results even in areas where no direct investigation was conducted.

Hyung-Koo Yoon is a professor in the Department of Disaster and Safety Engineering at Daejeon University. He earned his bachelor's, master's, and doctoral degrees at Korea University, specializing in geotechnical engineering for both his graduate degrees. After receiving his Ph.D. in 2011, he conducted postdoctoral research at the Georgia Institute of Technology. In 2012, he joined the faculty at Daejeon University. His research group focuses on applying non-destructive investigation techniques to various civil infrastructure systems, and in recent years, has been actively exploring the use of artificial intelligence methods to address geotechnical engineering challenges.

Clay Particle Transport in Sand Medium: Mechanisms and Applications

Jongmuk Won

Abstract

Understanding clay particle transport is challenging because of the aggregation kinetics of clay particles and the heterogeneity of surface charge-induced interaction between clay and sand. These unique characteristics of clay minerals lead to conventional colloid transport studies not appropriately explaining clay particle transport through a sand medium. This talk presents the aggregation behavior of clay particles as a function of solution chemistry. Then, the underlying mechanisms of clay particle transport in porous media are presented, along with laboratory experiments to assess the retention and transport of clay particles. In addition, the three applications of assessing clay particle transport are also introduced: formation of filter cake or clogging, internal erosion, and heavy metal transport through sand medium. The key findings shown in this talk include (1) the importance of clay particle aggregation and clay mineralogy on clay particle transport, (2) insight into the interaction energy in the clay particle transport and internal erosion, and (3) evidence of facilitation and retardation of clay particle-associated heavy metal transport. Several modeling techniques with future challenges to predict clay particle transport are also presented.

Jongmuk Won is an Associate Professor in the Department of Civil, Urban, Earth, and Environmental Engineering at the Ulsan National Institute of Science and Technology (UNIST). He received his Ph.D. in Civil and Environmental Engineering from Georgia Institute of Technology in 2017. Prof. Won's research group is now conducting multiple research topics, including internal erosion (suffusion, contact erosion, and backward erosion) of soils, developing a novel computational framework for geotechnical interpolation and solving complex geotechnical problems, improving the efficiency of carbon sequestration in granular materials, and clay science in geotechnical engineering.

Application of Electromagnetic Waves to Assess the Integrity of Geo-Infrastructures

Jung-Doung Yu

Abstract

Electromagnetic wave-based smart sensing techniques are widely used in geo-infrastructure to evaluate integrity. This study investigates a smart sensing technique based on electromagnetic waves to detect defects in rock bolts. Laboratory tests are carried out on one fully grouted bolt and eight defective rock bolts with designed imperfections: five featuring non-grouted section at the ends, each of a different length and three containing voids of different types. A two-conductor transmission line, constructed from an electrical wire and a rebar, was configured to propagate electromagnetic waves along its length. A time-domain reflectometer is used to generate and detect electromagnetic waves. Reflections of electromagnetic waves are observed at both defect locations and bolt ends. Results show that the velocity of electromagnetic waves increases with higher non-grouted ratios. Estimated defect locations corresponds closely to actual locations. This study demonstrates that a smart sensing based on electromagnetic-waves offers a precise, non-destructive approach for locating defects and quantifying non-grouted sections in rock bolts.

Jung-Doung Yu *is an assistant professor in the Department of Civil Engineering at the Jeonbuk National University (JBNU). He received his B.S. in Civil and Environmental Engineering and M.S. and Ph.D. in Geotechnical Engineering from Korea University. Prior to joining JBNU, he worked as a research scholar at Stanford University and University of California, Berkeley. His research focuses on smart sensing, disaster risk assessment and monitoring, LLM-based data management and analysis, site characterization, and geo-infrastructure health monitoring.*

Engineering Photo(electro)catalytic Materials for Sustainable Environment

Wonyong Choi

Abstract

The global environment is challenged by excessive consumption of fossil fuels and resources, which perturbs the nature's sustainable cycles of various chemical elements such as C, N, O, and H. As solar energy is the major driving force of the global cycles of these key elements, photo(electro)catalysis is an ideal engineering method to mimic and restore the nature's element cycles. The photochemical conversion of H_2O, CO_2, N_2, and O_2 has been intensively investigated employing various methods among which photo(electro)catalysis using semiconductor materials has been established as the most popular method. This talk will introduce several examples of photocatalytic and photoelectrochemical (PEC) conversions of C, N, and O compounds and discuss their environmental implications. The photocatalytic and photoelectrocatalytic processes have been applied to denitrification, de-NOx, and nitrogen fixation reactions but the successful performance is limited. The direct conversion of nitrogenous pollutants to dinitrogen and dinitrogen to ammonia without using chemical reductants is an ideal solution but difficult to be realized. Here we introduce various engineered photo(electro)catalytic systems that selectively interconvert among NO_3^-, NO_2^-, NO, NH_4^+, and N_2. As for O conversion, some examples of photocatalytic and photoelectrochemical systems for sustainable production of H_2O_2 through O_2 reduction will be introduced. A PEC system enabled continuous H_2O_2 production over 100 h even under a bias-free condition. As for CO_2 conversion, a unique example that controls the selectivity of the multi-electron transfer mechanisms of CO_2 transformation using heteronuclear dual-atom-site catalyst to generate an uncommon product (HCHO) will be discussed.

Wonyong Choi received B.S. from Seoul National University in 1988 and Ph.D. from CALTECH in 1996. Then, he worked at NASA Jet Propulsion Laboratory as a postdoctoral scholar. He joined the faculty of POSTECH in 1998. In 2022, he moved to Korea Institute of Energy Technology (KENTECH) to establish Center for Environmental and Climate Technology as an inaugural director. His research interests are mainly focused on semiconductor photo(electro)catalysis and photochemistry for solar energy conversion and environmental applications. He was elected as Fellow of Korean Academy of Science and Technology (KAST, 2014) and National Academy of Engineering of Korea (NAEK, 2023), and International member of U.S. NAE in 2024. He received Young Scientist Award (KAST) in 2005, KAST Science and Technology Award in 2015, Korea Engineering Award in 2018, and Korea Toray Science & Technology Prize in 2024. He has been selected as Highly Cited Researcher by Clarivate Analytics in 2019-2024. He is currently serving as an editor-in-chief of ACS ES&T Engineering and on the editorial advisory board of Nature Sustainability, Energy & Environmental Science, and Chem Catalysis.

Ti-Nb Oxide Nanotube Arrays with Cathodic Engineering for Photoelectrochemical Water Treatment

Kangwoo Cho

Abstract

Amid the growing attention to the water pollution caused by recalcitrant organic micropollutants and concomitant demands on (industrial) wastewater reuse, photoelectrochemical (PEC) water treatment has been noticed as a feasible advanced oxidation process with minimal usage of chemicals with H_2 generation. Cathodization of TiO_2 nanotube array (TNA) in ambient conditions has been widely deployed to enhance the PEC activities. Self-dopants (Ti^{3+}, intercalated H, and oxygen vacancy) or heteroatom dopants could tune the band structure, light absorbance, electrical conductivity, capacitance, and charge transfer characteristics among others. This study systematically evaluated the effects of variable cathodization conditions, including current density/duration, pH/buffering intensity of electrolyte, and sequence of annealing. This study stepped further for engineering of Nb_2O_5 nanotube array (NNA) and Nb-doped TNA (Nb-TNA) via analogous cathodization doping. The PEC activity for aqueous pollutants degradation and photocurrent generation (for H_2 generation on cathode) were comparatively evaluated. The doping mechanism was disentangled by thorough characterization based on X-ray diffraction, X-ray photoelectron/absorption spectroscopy, electron spin resonance spectroscopy, and secondary ion mass spectroscopy.

Kangwoo Cho is associate professor in Pohang University of Science and Technology (Postech). Kangwoo Cho received his B.S./M.S. in Civil, Urban, and Geosystem Engineering from Seoul National University. He has served as a full time research scientist at Korea Institute of Science and Technology (KIST) from 2006 to 2016. During 2010-2014, he persued Ph.D at California Institute of Technology (Caltech). Dr. Cho's research interests nowadays span broadly in environmental electrochemistry, electrocatalysts and processes based on the principles in electrolysis/fuel cell, capacitor, battery and photovoltaic. His research ultimately seeks towards wastewater refinery to harvest clean water, energy, and resources from wastewater.

Advancing Photochemical Technologies for Controlling Emerging Contaminants in Urban Water Systems

Yunho Lee

Abstract

Climate change, intensified algal blooms, and increased wastewater discharge are placing growing pressure on drinking water sources and urban water systems. These stressors contribute to the spread of biological and chemical contaminants, including hormones, pharmaceuticals, antibiotic resistance genes, and viruses, many of which are not effectively removed by conventional treatment processes. Addressing these emerging threats requires innovative water treatment and analysis technologies. Among these, light based technologies such as ultraviolet (UV) disinfection and UV driven advanced oxidation processes are gaining attention for their effectiveness, scalability, and versatility. These technologies play an important role in inactivating pathogens and degrading both chemical and biological contaminants, and they also offer potential as analytical tools for tracking contaminants. This talk will present our recent and ongoing research aimed at advancing light based technologies for urban water quality engineering. Key topics include (1) understanding DNA degradation through photolysis and its implications for controlling antibiotic resistance genes and viruses, and (2) investigating the photochemistry of (halogenated) organic nitrogen moieties and its implications for managing nitrogenous organic contaminants. By combining photochemical principles with practical applications, our work contributes to the development of more resilient and sustainable urban water systems.

Yunho Lee is a full professor in Department of Environment and Energy Engineering at Gwangju Institute of Science and Technology (GIST), Korea. His researches focus on advanced water quality analysis using mass spectrometry and bioanalytical tools, as well as advanced water treatment technologies, with core expertise on water disinfection and oxidation processes. He has authored or co-authored over 100 publications in the field of water science and engineering, and currently serving as an editor of Water Research and executive editor of Journal of environmental chemical engineering.

(Photo)electrocatalytic Destruction of Emerging Contaminants via In-Situ Generation of Reactive Oxygen Species

Hyoung-il Kim

Abstract

The in-situ generation of reactive oxygen species (ROS) through photo(electro)catalysis has emerged as a powerful and sustainable approach for the degradation of emerging contaminants in water treatment. This technique leverages solar or electrical energy to activate catalytic materials, enabling the production of highly reactive species such as hydroxyl and superoxide radicals directly from water and dissolved oxygen. In this study, we present recent advancements in the development of (photo)electrocatalytic systems tailored for ROS-mediated contaminant degradation. Key design principles, reaction mechanisms, and operational parameters influencing ROS generation and pollutant removal efficiency are discussed. We also highlight the environmental benefits and practical implications of deploying these technologies in real-world water purification systems.

Hyoung-il Kim is an Associate Professor in the Department of Civil and Environmental Engineering at Yonsei University, he currently serves as the Yonsei Lee Youn Jae Rising Fellow. He received his Ph.D. from Pohang University of Science and Technology (POSTECH) in 2014. From 2014 to 2017, he conducted postdoctoral research at Yale University before joining Yonsei University as an Assistant Professor in 2017. Dr. Kim's research group is actively involved in a range of interdisciplinary research projects focused on solar-driven catalysis, including advanced oxidation processes (AOPs) for water and air treatment, resource recovery, solar fuel production, and (photo)electrochemical nitrogen conversion.

Integrated Strategies for High-Efficiency and Stable Perovskite Solar Cells

Sang Il Seok

Abstract

Perovskite solar cells (PSCs) have rapidly progressed from an initial certified efficiency of 3.8% in 2009 to over 27% today, propelled by advances in thin-film chemistry, interfacial engineering, and device design. Achieving commercially viable, stable modules, however, requires a deeper understanding of the coupled chemical and physical phenomena governing film formation, charge transport, and degradation. This presentation outlines our group's decade-long research into these processes, emphasizing the role of alkylammonium chlorides—especially methylammonium chloride (MACl)—in promoting improved crystallinity and compositional uniformity in $FAPbI_3$ films. Despite their widespread use, the reaction pathways among $FAPbI_3$, MACl, and their by-products have remained poorly understood. Our studies reveal how the in situ formation of methyl-formamidinium (MFA^+) species alters phase behavior and defect formation, thereby influencing device efficiency and stability. In this talk, I will discuss our recent work on low-temperature-processable inorganic electron-transport layers combined with targeted surface passivation strategies.

Sang Il Seok is a Distinguished Professor in the Department of Energy and Chemical Engineering at Ulsan National Institute of Science and Technology (UNIST), Korea. He received his Ph.D. in Inorganic Materials Engineering from Seoul National University and subsequently conducted postdoctoral research at Cornell University, USA, where he focused on defects and transport phenomena in Fe-Ti-O spinel structures. Prior to joining UNIST in 2015, Prof. Seok served as a principal investigator at the Korea Research Institute of Chemical Technology (KRICT) and concurrently held a full professorship in the Department of Energy Science at Sungkyunkwan University. His pioneering contributions to the development of perovskite solar cells have established him as a leader in the field. Prof. Seok's outstanding achievements have been recognized with numerous prestigious honors, including the Korean Scientist Award from the Korean government (2017), the Kyung-Ahm Prize (2019), the Rank Prize (2022), and the Humboldt Research Award (2025) for his groundbreaking work in perovskite solar cell technology.

Perovskite-based Tandem Solar Cells

Jin Young Kim

Abstract

Perovskite/Si double-junction (2J) tandem solar cells are attracting interest due to their rapidly increasing efficiency. Their certified record efficiency (34.9%, as of July 1st, 2025) has surpassed the theoretical limit efficiency of single-junction (1J) solar cells. In this presentation, research progresses in the perovskite-based tandems done in our laboratory will be briefly introduced, especially focusing on strategies to achieve record-high efficiencies and good stability.[1-5] Recent works for utilizing commercial bottom cells such as PERC Si and CIGS will also be discussed.[6]

References

[1] Park et al., Joule, 3, 807 (2019)
[2] Kim et al., Science, 368, 155 (2020)
[3] Ji et al., Joule, 6, 2390 (2022)
[4] Choi et al., ACS Energy Lett., 8, 3141 (2023)
[5] Hwang et al., Energy Environ. Mater., 7, e12489 (2024)
[6] Park et al., ACS Energy Lett., 10, 3743 (2025)

Jin Young Kim is a Professor at Seoul National University (SNU), Seoul, Korea. He received his B.S. (2000), M.S. (2002), and Ph.D. (2006) degrees in Materials Science at SNU. Before joining SNU in 2015, he worked at the National Renewable Energy Laboratory (NREL), USA (2007-2011), and Korea Institute of Science and Technology (KIST), Korea (2011-2015). His current research interests focus on the high-efficiency perovskite-based tandem solar cells and solar-powered green electrocatalysts (e.g., HER, OER, and CER). He has reported record efficiencies for various types of solar cells (e.g., p-i-n perovskite, perovskite/Si tandem, CZTSSe, perovskite/CZTSe tandem, perovskite/perovskite/Si tandem, and perovskite/CIGS tandem) and green electrocatalysts (e.g., PV-EC and PV-PEC for HER and CER).

Efficient and Stable Perovskite Solar Cells through Interface and Additive Engineering

Jangwon Seo

Abstract

Over the past 15 years, the power conversion efficiencies (PCE) of perovskite solar cells (PSCs) have increased from 3.8% to 27% since 2009. Most highly efficient PSCs employ an n-type layer of tin oxides or fullerene derivatives in an n-i-p or p-i-n device configuration, where organic or polymer conductors are commonly used to transport holes into the electrode. Numerous efforts have thus far been devoted to achieving a defect-free perovskite film with high-quality morphologies for achieving reduced loss-in-potential results and increased efficiency levels. These comprehensive advances in interface engineering, additive engineering, composition engineering, and charge-transporting layer engineering for perovskite solar cells us to attain high-performing PSCs. In this talk, I will provide a concise overview of the evolution of PSCs and the most significant developments that have advanced their performance. Furthermore, I will present our efforts to ensuring both high efficiency and long-term stability. Specifically, I will discuss the rational design of the interface layer and hole-transporting layer (HTL) system for realizing efficient and stable PSCs and also present our recent research on the introduction of new dual-functional ionic liquid (IL) dopants into the HTL. Finally, I will discuss additive engineering of two-step fabricated PSCs, which could improve the efficiency and the stability by regulating the crystallographic orientation of the perovskite crystals in thin film and mitigating the lattice strain of the perovskite film.

Jangwon Seo is a KAIST endowed chair professor in the Department of Chemical & Biomolecular Engineering at the Korea Advanced Institute of Science and Technology (KAIST). He received his B.S., M.S., and Ph.D. from Seoul National University in 1998, 2000, and 2006, respectively. Then, he worked at the University at Buffalo, the State University of New York, as a postdoctoral researcher. Before joining KAIST in 2021.5, he was a senior/principal researcher at the Korea Research Institute of Chemical Technology (KRICT) from 2013 to 2021.4. His research focuses on the development of efficient & stable hybrid perovskite solar cells and organic-polymer semiconductors for opto-electronic applications.

Reproducible Fabrication of Metal Halide Perovskite Solar Cells: From Solution to Vapor Deposition

Jin-Wook Lee

Abstract

Production yield is a critical bottleneck in the commercialization of advanced technologies, directly impacting cost competitiveness and scalability—as widely observed in the semiconductor and display industries. While perovskite solar cell (PSC) technology has shown remarkable progress in terms of efficiency and stability, issues related to reproducibility, which directly influence production yield, have received comparatively limited attention. In this presentation, I will first highlight the pivotal role of atmospheric humidity in governing the crystallization dynamics and phase stability of solution-processed perovskite thin films. We show that variations in humidity content during processing lead to significant differences in perovskite stoichiometry, thermodynamic stability, and optoelectronic properties, ultimately affecting both the photovoltaic performance and the reproducibility of PSCs. Finally, I will introduce our recent efforts to achieve reproducible fabrication of PSCs via a vacuum thermal evaporation process, demonstrating highly consistent device performance and scalability potential.

Jin-Wook Lee is a SKKU Fellowship Professor at Sungkyunkwan University (SKKU) Advanced Institute of Nanotechnology (SAINT) and Department of Nanoengineering at SKKU. He received his B.S. in Electronic and Electrical Engineering and Ph.D. in Energy Science from SKKU in 2011 and 2016, respectively. From 2016 to 2019, he worked as a Postdoctoral Researcher at the University of California at Los Angeles (UCLA) before joining SKKU as an Assistant Professor in 2019. His research focuses on optoelectronic devices based on inorganic and organic-inorganic hybrid crystals. He is author and co-author of 130 peer-reviewed scientific papers including Nature, Science, Nature Materials, Nature Energy, Joule. He received Young Scientist Award (2013) from E-MRS, 2021 POSCO Science Fellowship from POSCO TJ Park Foundation, 2022 top 10 Nanotechnologies from Korean government, 2022 Gyeonggi-do Young Scientist Award by Governor of Gyeonggi Province. He was selected as highly cited researchers (HCR, top 1% citation index) in 2021-2024 by Clarivate Analytics. He currently serves as an editorial advisory board member of ACS Energy Letters, J Phys Energy, Nano Research Energy.

Assessment of Structural Vulnerability to Tsunami Loading Considering Wave and Bathymetry

DoSoo Moon

Abstract

Tsunamis pose a major threat to coastal infrastructure, often resulting in extensive structural damage and significant loss of life. Although current design standards provide guidance for estimating tsunami loads, they rely on simplified assumptions that may not reflect the true complexity of site-specific conditions. This study examines how structural vulnerability is affected by key wave and bathymetric parameters. The analysis considers wave period, crest and trough amplitudes, and the number of wave cycles, as well as offshore and onshore slopes, ground roughness, and building distance from the shoreline. Inundation depth and flow velocity are evaluated at selected locations along the coast and used to estimate hydrodynamic loading. These values inform the development of fragility curves for different structural performance levels. Results show that steeper slopes, higher surface friction, longer wave periods, and greater setback distances generally reduce structural vulnerability. In contrast, higher crests and repeated wave loading increase the likelihood of failure. Trough depth is found to have limited influence under the examined conditions. The study also identifies notable differences between simulation-based forces and estimates from design codes, particularly in the timing and shape of force histories. To improve load characterization, updated normalized curves for inundation depth and flow velocity are proposed. These findings support more accurate structural assessments and contribute to improved design strategies for tsunami resilience.

DoSoo Moon is an Associate Professor in the Department of Civil, Environmental, and Construction Engineering at the University of Hawai‘i at Mānoa. He received his Ph.D. from the University of Illinois at Urbana-Champaign, where he later served as a postdoctoral research associate at the Mid-America Earthquake (MAE) Center and the Smart Structures Technology Laboratory. During that time, he oversaw the Multi-axial Full-scale Substructure Testing and Simulation (MUST-SIM) facility. His research focuses on multi-hazard resilient and sustainable infrastructure systems, structural risk assessment and mitigation, advanced structural design and retrofit methods, structural performance evaluation under extreme loading conditions, structural health monitoring with smart sensor technologies, and the application of machine learning and artificial intelligence in structural engineering.

Infrastructure Monitoring: Advanced Techniques for Rapid Structure Evaluation and Sinkhole Prevention

Suyun Paul Ham

Abstract

These issues — including sinkholes, bridge collapses, and pavement deterioration — are part of a broader, systemic concern: global infrastructure resilience. This seminar, Infrastructure Monitoring including various field testing results, focuses on two critical applications: automated pipeline inspection for sinkhole prevention (Part I) and rapid bridge evaluation techniques Part II). Part I focuses on automated pipeline inspection for sinkhole prevention, presenting an analytical, numerical, and experimental study of Rayleigh wave scattering from internal vertical cracks (SWS-IVC). The model is validated through finite element simulations and lab testing. Key contributions include crack depth estimation using wave response variation curves and improved subsurface crack detection via air-coupled MEMS sensor arrays, based on wave energy attenuation. Part II introduces a multi-input model for rapid bridge damage detection. By integrating time-domain, frequency-domain, and STFT signals from impact-echo testing, the model achieves 87% accuracy using combined frequency and STFT inputs. Performance is optimized for resolution with certain input images. The study also explores model overfitting mitigation using validation curve analysis to enhance model robustness.

Suyun Paul Ham is currently an Associate Professor at the University of Texas at Arlington. He also holds his Civil Engineering Professional Engineer license. He finished his Ph. D. in Civil Engineering at the University of Illinois at Urbana-Champaign. Before that, he worked in industries for seven years as a researcher and a structural engineer on projects for more than 100 buildings and infrastructure designs. Dr. Ham's interest area is nondestructive evaluation and structural health monitoring His research interests include nondestructive testing with advanced sensing where he applies mechanical and magnetic field phenomena to assess the condition of infrastructure. His secondary interests lie in material characterization and advanced machine learning (ML) and artificial intelligence (AI). He perform various infrastructure damage assessment field and laboratory testing include rail structures, bridge structures, and nuclear power plants. Dr. Ham is also an expert in full-scale structural experiment testing, advanced numerical analysis, and innovative sensing development.

Perspectives on Water Distribution, Energy, and Sustainability; Some Observations from North American

Bryan Karney

Abstract

Through its water and energy systems runs the life blood of any society. The associated delivery infrastructure has the potential to sustain urban life and vitality but, if poorly managed, is also capable of inflicting great distress, huge costs and wide-spread disruptions on urban populations. There are many challenges and constraints in this domain, as the infrastructure systems that deliver the key services are often hidden, are vast in spatial scale, and often taken-for-granted. The unachieved gold standard is for these built systems to be durable, resilient, robust, long-lived, adaptable and economical. This talk will specifically focus on how engineers, or other decision makers, need to understand the realities of this context and to distinguish between problems and challenges, between issues of the past, present and future, and to recognize the crucial need for widespread communication and compromise across sectors. One of the key issues is resourcing and undervaluing the foundation role water and energy systems play in human and economic health, leading to a tendency of short-termism. In this domain as in so many others, a mostly reactive stance can preclude the needed long-term planning on planning and investment.

Bryan Karney is a Professor of Civil Engineering at the University of Toronto, where he has taught since 1987. He holds a Ph.D. in Civil Engineering from the University of British Columbia and has over 40 years of experience in hydraulic systems across water, wastewater, stormwater, oil, gas, and jet fuel networks. He is also a co-founder of HydraTek, a leading consulting firm in water systems engineering. Bryan has published several hundred papers and co-authored several books. He has served as associate editor for journals including Journal of Hydraulic Research and Urban Water Journal, and received numerous awards for teaching and research. His work has earned him recognition among the top 2% most cited STEM researchers globally. He continues to supervise Ph.D. students and has mentored over 25 Ph.D. and 100 master's students. Notably, he supervised Mohamed Ghidaoui and Duncan McInnis, both affiliated with HKUST. In administration, Dr. Karney led the launch of U of T's Associate Dean Cross-Disciplinary Programs role, establishing over a dozen engineering minors including Sustainable Energy and Robotics. By the end of his tenure, over half of engineering graduates earned credentials from these programs.

Evolution, Recent Trends and Future Directions of European Research on Water Distribution Networks

Enrico Creaco

Abstract

The European research on water distribution networks (WDNs) started in the first decades of the twentieth century, with a focus on the modelling. Then, it expanded to include other aspects, such as the design. Without forgetting modelling and design, which were then tackled by using increasingly complex and comprehensive approaches and by considering more and more realistic assumptions, new research lines were then started between the end of the twentieth century and the beginning of the twenty-first century, including those concerning management, risk assessment and water quality. After briefly mentioning the evolution of European research topics in WDN context, my talk will proceed to the description of current research trends, taking inspiration from papers presented at recent European conferences, dwelling on topics such as demand forecast, in-line and off-line management, integration with power grids, artificial intelligence and machine-learning, development of digital-twins, protection of WDNs from contamination and transient flow analysis. The talk will finally outline the still open questions and the potential avenues for future research, also considering the real world challenges.

Enrico Creaco is a Full Professor of Hydraulic Infrastructures at the University of Pavia, Italy. He has been lecturer for almost fifteen years at both undergraduate and postgraduate level and has published more than 140 papers in Scopus and ISI indexed international journals. He is an Associate Editor of the Journal of Water Resources Planning and Management-ASCE and is in the editorial board of various journals, including Scientific Reports-Nature, Sustainable Cities and Society-Elsevier and Water-MDPI. He participated in/coordinated various national and international research projects. Since the year 2024, he has been in the control group of the Water Distribution Systems Analysis (WDSA) committee, responsible for the organization of the sessions on water distribution networks at the EWRI conference. His research interests include: Modelling, optimization and management of water distribution, urban drainage and irrigation systems, modelling of intense rain events under climate change scenarios, modelling of landslide triggering and runoff.

Historical Overview and Future Challenges of Water Distribution System Research in Korea, with a Particular Focus on Korea University

Sanghoon Jun

Abstract

Research on water distribution systems (WDSs) has evolved significantly over the past few decades. In Korea, Joong Hoon (Jay) Kim, Emeritus Professor in the Department of Civil, Environmental, and Architectural Engineering at Korea University, has made substantial contributions to this field. His pioneering work has laid the foundation for key areas of WDS research, including optimal WDS operation and management, hydraulic modelling, network design, system resilience and reliability, and failure detection such as leak identification. Notably, his development of Harmony Search, a novel meta-heuristic optimization algorithm, has had a profound global impact on WDS optimization research. In the current era of big data and artificial intelligence (AI), the WDS field continues to evolve, with state-of-the-art techniques being applied to address both longstanding and emerging challenges in WDSs. This presentation will first provide a historical overview of WDS research in Korea, with a particular focus on the contributions of Prof. Kim's lab. It will then explore future challenges and opportunities to advance the field through AI-driven, smart, and resilient system approaches.

Sanghoon Jun is an Assistant Professor in the Department of Civil Engineering at Chungnam National University in Daejeon, South Korea. He earned his B.S. and M.E. degrees in Civil, Environmental, and Architectural Engineering from Korea University, and completed his Ph.D. in Civil and Architectural Engineering and Mechanics at the University of Arizona. His research centers on urban water networks, with a primary focus on water distribution and urban drainage systems. He is particularly interested in leveraging state-of-the-art deep learning techniques to address critical water-related challenges, such as failure detection and flood mitigation.

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