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Organized by f-PHI Hyper-converged Forensic Research Center for Infrastructure, KOREAN GEOTECHNICAL SOCIETY, KSSC KOREAN SOCIETY OF STEEL CONSTRUCTION, KOSHAM KOREAN SOCIETY OF HAZARD MITIGATION

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Day 3 Advanced Structural Engineering / AI, ML and Optimization Technique for Water and Environmental Forensic Engineering — Jan 25, 2024

09:50-10:00	**Introductory Comments & Welcoming Address**

Session 1 : Forensic Structural Engineering I — *Chair: Seungjun Kim*

10:00-10:30	**Crack Patterns of Unbonded Post-Tensioned Members and Seismic Retrofitting Techniques Using CFRP** **Uksun Kim** (Professor, California State University - Fullerton, USA)
10:30-11:00	**Structuring Shear Wall Buildings Based on Artificial Neural Networks** **Leonardo Massone** (Professor, University of Chile, Chile)
11:00-11:30	**Integrating Machine Learning into Building Codes: Establishing Equivalence through Causality and Intuition** **M.Z. Naser** (Professor, Clemson University, USA)
11:30-12:00	***QnA Session***
12:00-13:00	*Lunch*

Session 2 : Forensic Structural Engineering II — *Chair: Thomas Kang*

13:00-13:30	**Study on Failure Modes and Load-Carrying Capacity of a Transmission Tower** **Seungjun Kim** (Professor, Korea University, South Korea)
13:30-14:00	**Impact Performance of Reinforced and Post-Tensioned Concrete One-Way & Two-Way Members** **Thomas Kang** (Professor, Seoul National University, South Korea)
14:00-14:30	**Advancing Roller-Compacted Concrete Pavements for Heavy-Load Container Terminals: A Study on Optimizing Structural Design under Increased Stacking Pressures** **Emin Sengun** (Professor, Ankara Yildirim Beyazit University, Türkiye)
14:30-15:00	***QnA Session***

Session 3 : AI, ML and Optimization Technique for Water and Environmental Forensic Engineering — *Chair: Donghwi Jung*

15:00-15:30	**System and Model Robustness for Hydrosystems in the Era of the Fourth Industrial Revolution** **Donghwi Jung** (Professor, Korea University, South Korea)
15:30-16:00	**Advancing Real-Time In-Situ Environmental Monitoring Using Autonomous Unmanned Vehicles** **Jae Hyeon Ryu** (Professor, University of Idaho, USA)
16:00-16:30	**Artificial Electric Field Algorithm for Training Multilayer Perceptron Models** **Anupam Yadav** (Professor, Dr. B. R. Ambedkar National Institute of Technology Jalandhar, India)
16:30-17:00	**Artificial Intelligence for Advancing Water Treatment Research and Development** **Nurul Alvia Istiqomah** (Lecturer, Universitas Gadjah Mada, Indonesia)
17:00-17:30	***QnA Session***
	Closing Comments

Crack Patterns of Unbonded Post-Tensioned Members and Seismic Retrofitting Techniques Using CFRP

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In high-seismic areas such as California, damage and collapse of buildings due to earthquakes have always been a major concern. Therefore, lots of research has been conducted to mitigate seismic hazards through government agencies, professional organizations, and universities. Especially, the demand to secure the seismic safety of the unbonded post-tensioned building system is increasing in California because unbonded post-tensioned members are widely used in parking structures. In this research, the crack patterns of unbonded post-tensioned members, such as beams (single-span and two-span beams) and slabs (one-way and two-way slabs), were experimentally investigated. Based on these experimental results, effective repair and retrofitting methods using CFRP (Carbon Fiber Reinforced Polymer) are proposed.

Uksun Kim is a Professor of Civil and Environmental Engineering at California State University – Fullerton. He received his B.S. degree in Architectural Engineering from Yonsei University (Seoul, Korea). He has two M.S. degrees. One is from Yonsei University in the field of Architectural Engineering, and the other is from Michigan State University (East Lansing, MI, USA) in the field of Civil Engineering. He earned his Ph.D. with an emphasis in structural engineering from the School of Civil & Environmental Engineering at the Georgia Institute of Technology (Atlanta, GA, USA).

He has more than 30 years of experience working on experimental and analytical investigations of building structures, both at a research institute in Korea and at universities in the US. He carried out many research projects successfully, such as the development of light-gauged steel frame housing, seismic design of steel joist girder structures, seismic rehabilitation of prestressed building systems, etc. For his outstanding accomplishments in teaching and research, he received the "2014 Outstanding Engineering Educator Award" from the Orange County Engineering Council and the "2016 Distinguished Faculty Member in ECS (College of Engineering & Computer Science)" from CSUF (California State University-Fullerton).

He is a licensed professional engineer and a LEED AP (Leadership in Energy and Environmental Design Accredited Professional). And, he served as the Department Chair from 2012 to 2018.

Structuring Shear Wall Buildings Based on Artificial Neural Networks

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Residential reinforced concrete building design relies on close collaboration between architectural and engineering offices to improve the distribution of living spaces while meeting structural regulatory requirements. Several studies have taken advantage of the vast amount of data generated by both offices to create machine-learning models that streamline design processes and decision-making. Recent research proposed an artificial neural network (ANN) model for predicting the length and thickness of the rectangular segments that constitute the plan's walls based on the architectural data; however, it couldn't predict walls absent from the original design. This constraint was addressed by a convolutional neural network (CNN) model, demanding a larger dataset (by 137 times) and several rule-based filters for assembling the predicted plan, incurring high computational costs, and generating blurry predictions. Therefore, this study presents the previous and a new methodology to propose walls and columns that were not considered in the architectural design through an ANN model, which employs fewer data than the CNN but with comparable results.

Leonardo M. Massone is a Professor at the University of Chile and Technical Manager at IDIEM from the same University. He received his BS degree from the University of Chile, and his MS and Ph.D. degrees from the University of California, Los Angeles. He teaches concrete design, advance concrete design and nonlinear analysis of structures classes. His research interests include analytical and experimental studies of reinforced concrete systems, with emphasis on seismic response. He has written more than 60 articles indexed in WoS (Web of Science). He has received both national recognition, such as from the Chilean Institute of Engineers (2014), and international recognition, such as the "Young Professor Best Paper Award" for the 36th Conference on Deep Foundations (USA, 2011), "Best Paper Award" for the 10th International Congress on Advances in Civil Engineering, (Turkey, 2012) and for the Structural Design of Tall and Special Buildings journal (USA, 2017). He was Director of the Civil Engineering Department between 2014 and 2018 and since 2023 is technical manager at IDIEM. He was a voting member of an ACI 318 sub-group for the 2019 version and is currently the coordinator for the update of the Chilean design code for reinforced concrete structures, NCh430.

Integrating Machine Learning into Building Codes: Establishing Equivalence through Causality and Intuition

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The traditional approach to formulating building codes is often slow, labor-intensive, and may struggle to keep pace with the rapid evolution of technology and domain findings. Overcoming such challenges necessitates a methodology that streamlines the modernization of codal provisions. This seminar proposes a machine learning (ML) approach to append a variety of codal provisions, including those of empirical, statistical, and theoretical nature. In this approach, a codal provision (i.e., equation) is analyzed to trace its properties (e.g., engineering intuition and causal logic). Then a ML model is tailored to preserve the same properties and satisfy a collection of similarity and performance measures until declared equivalent to the provision at hand. The resulting ML model harnesses the predictive capabilities of ML while arriving at predictions similar to the codal provision used to train the ML model, and hence, it becomes possible to adopt in line with the codal expression. This approach has been successfully examined on seven structural engineering phenomena contained within various building codes, including those in North America and Australia. Our findings suggest that the proposed approach could lay the groundwork for implementing ML in the development of future building codes.

M.Z. Naser is a professional engineer and an assistant professor at the School of Civil and Environmental Engineering and Earth Sciences at Clemson University and a faculty member of the AI Research Institute for Science and Engineering (AIRISE). Dr. Naser serves as the current chair of the American Society of Civil Engineers (ASCE). Advances in Information Technology (AIT) committee and a voting member of various national and international engineering institutions. Dr. Naser's research creates causal and explainable machine learning methodologies to help us realize functional, sustainable, and resilient infrastructure. He has co-authored over 140 peer-reviewed publications, including a new textbook on machine learning and civil engineering, titled "Machine Learning for Civil and Environmental Engineers: A Practical Approach to Data-Driven Analysis, Explainability, and Causality" by Wiley. He is listed in the company with the world's most impactful researchers by Elsevier and Stanford University, ranking among the world's top 2% of scientists for two constitutive years (2022-2023). Outside of his research interests and teaching activities, Dr. Naser most enjoys spending time with his wife and family, and when time permits, his favorite hobbies are hiking and working out.

Study on Failure Modes and Load-Carrying Capacity of a Transmission Tower

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Transmission towers are classified as the lattice structure which consists of main posts, horizontal members, and braces. Although many large-scale infrastructures are being designed based on the load and resistance factor design (LRFD) method, the high-rise lattice structures have been designed through the allowable stress design (ASD) method in Korea. The Korean Society of Steel Construction (KSSC) research team was funded by the Korea Electric Power Research Institute (KEPRI) to develop the LRFD-based design specification in 2021. Conducting the project, we have investigated the ultimate behavioral characteristics of the transmission towers. As well as the nonlinear finite element analysis, we conducted the full-scale experiment of the tower. The experiment's objectives are to study the feasibility of the developed LRFD-based design specification and investigate the failure modes and load-carrying capacity. According to the experiment, the structure can show buckling of main posts owing to the unbalanced forces induced by line breaks and strong winds. In this presentation, I show the details of the failure modes, load-carrying capacities, and critical load combinations.

Seungjun Kim, an associate professor at Korea University, received the bachelor´s degree in civil engineering from Korea University, Seoul, South Korea in 2004, the M.S. degree in structural engineering in 2006, and the Ph.D. degree in structural engineering from Korea University in 2010. He worked as a postdoc research associate at Texas Transportation Institute and Texas A&M ocean engineering division from 2012 to 2014. In 2014, he joined Samsung Heavy Industries as a senior researcher. In the company, he has conducted many projects to develop the effective design and analysis method for very large offshore oil&gas platforms. He worked at the department of construction safety and disaster prevention engineering at Daejeon university from 2016 to 2019. Then, he finally joined the school of civil, environmental and architectural engineering at Korea University as an assistant professor.
Dr. Seungjun Kim is the director of the structural system laboratory of Korea University. The main research interests are innovative numerical simulation, development of advanced offshore floating systems including renewable energy facilities, AI-based smart structural monitoring technologies, and effective construction safety technologies. He has published more than 70 SCI(E) indexed papers for structural engineering.

Impact Performance of Reinforced and Post-Tensioned Concrete One-Way & Two-Way Members

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In this presentation, the impact performance of reinforced and post-tensioned concrete one-way & two-way members will be dealt with in the perspective of forensic engineering. First, new energy-based models for the prediction of high-velocity and low-velocity impact performances of one-way members will be briefly introduced. A lack of specific data regarding the high-velocity and low-velocity impact performances such as those for post-tensioned members, two-way members, etc. is identified from the comparison between the existing test database and the prediction of penetration depth, residual velocity, and maximum deformation. To bridge the gap, new high-velocity impact tests and drop-weight low-velocity impact tests on unbonded post-tensioned two-way members, which have not been investigated by previous studies, are being conducted and will be presented in depth in this event. The effect of prestressing on the impact performance has been noted and the observed damage patterns and response mechanisms can be used in forensic investigating. Finally, numerical analyses conducted to predict the behavior of the test specimens and untested specimens will be explained, along with the related ongoing and future study.

Thomas Kang is a professor in the Department of Architecture & Architectural Engineering at Seoul National University (SNU), Korea. Before that, he was a professor in the School of Civil Engineering and Environmental Science at the University of Oklahoma and a Licensed Professional Engineer in the State of California. He also has held various affiliated positions in the U.S., Japan and South Africa, including UCLA, University of Illinois at Urbana-Champaign, University of Hawaii at Manoa, University of Tokyo and University of Cape Town. Prof. Kang received his Ph.D. from UCLA, his MS from Michigan State, and his BS from SNU.
He is a Fellow of Post-Tensioning Institute (PTI) and American Concrete Institute (ACI), and a member of National Academy of Engineering of Korea and Korean Academy of Science and Technology, as well as a member of EU Academy of Sciences.
He received several prestigious awards, including the Kenneth B. Bondy Award for Most Meritorious Technical Paper as Lead Author from PTI in 2012 and 2023, the Wason Medal for Most Meritorious Paper as Lead Author from ACI in 2009, and the Martin P. Korn Award as Responsible Author from PCI (Precast/Prestressed Concrete Institute) in 2023. He currently serves as an Editor-in-Chief for the Journal of Wind & Structures and as the Associate Editor for the PTI Journal. Prof. Kang has published over 175 international journal papers, including over 55 in ACI Structural Journal, over 15 in ASCE Journal of Structural Engineering, and over 15 in PTI / PCI Journals. His research interests include the design and behavior of reinforced, prestressed and post-tensioned concrete structures, as well as dynamic effects (wind, seismic, fire and shock) on structures.

Advancing Roller-Compacted Concrete Pavements for Heavy-Load Container Terminals: A Study on Optimizing Structural Design under Increased Stacking Pressures

Emin Sengun[1], Sunghwan Kim[2], Halil Ceylan[2]
Ankara Yildirim Beyazit University[1], Iowa State University[2] esengun@aybu.edu.tr

This study explores the advancement of Roller-Compacted Concrete (RCC) pavement structural designs in container terminals, addressing the increased stress challenges due to higher stacked container loads. Traditional container storage areas have utilized diverse paving materials, including gravel, concrete beams, asphalt, and pavers. However, the recent practice of stacking containers up to eight levels has dramatically increased pavement surface stress, heightening the risk of rapid degradation. This study employs finite-element software to identify container loading configurations causing maximum stress and deformation, a vital step for devising robust RCC pavement structural designs for such high-load situations. Through comprehensive parametric analysis, it offers insights into the effects of various subgrade reactions, material strengths, and stacking heights. It also introduces transfer functions to calculate the minimum thickness needed for RCC pavements under these conditions. This research marks a significant contribution towards a detailed structural design guide for RCC pavements, tailored for the unique demands of modern stacked container storage in container terminals.

Emin Sengun, serving as an assistant professor at Ankara Yildirim Beyazit University, has an educational background in civil engineering. His academic achievements began with a bachelor's degree in civil engineering, earned with high honors from Yildiz Technical University, Istanbul, Türkiye, in 2010. He then continued his studies at Istanbul Technical University, earning an M.S. in Soil Mechanics and Geotechnical Engineering in 2013. In 2019, Dr. Sengun received his Ph.D. in the Construction Materials Division from Middle East Technical University (METU), where he was awarded the METU Graduate Award – Ph.D. Award for Contributing to Technological Development.

Following his doctoral studies, Dr. Sengun was granted a postdoctoral research scholarship from The Scientific and Technological Research Council of Türkiye (TUBITAK). He furthered his research as a research scholar at Iowa State University's Program for Sustainable Pavement Engineering and Research (PROSPER) from 2022 to 2023. During his research term, he collaborated with the Roller-Compacted Concrete (RCC) Research Council in the US, focusing on developing a design methodology for engineers to design RCC pavements for stacked container terminals. Dr. Sengun's primary research interests include concrete pavement technology, pavement design, and material characterization. He has authored over 30 peer-reviewed indexed papers, demonstrating his significant contributions and expertise in his field.

Sunghwan Kim, P.E., is an Associate Director of the Program for Sustainable Pavement Engineering and Research (PROSPER) and a Research Scientist at the Institute for Transportation at Iowa State University (ISU). He also serves as Adjunct Assistant Professor at the ISU Civil, Construction, and Environmental Engineering (CCEE) Department. Dr. Kim holds a Bachelor of Science degree (Korea University 1999), a Master of Science degree (Iowa State University 2004), and a doctorate (Iowa State University 2006), all in civil engineering. His credentials are further enhanced by a Professional Engineering (PE) license from the State of Michigan.

Dr. Kim's career is distinguished by his significant contributions to transportation and geo-infrastructure engineering. At ISU, he has played a pivotal role in over 40 competitively funded research projects, attracting more than $14.5 million in project funds, where he served as co-principal investigator and in 16 research projects as a technical specialist, focusing on both paved and unpaved road systems and their construction materials. His prolific academic output includes authoring and co-authoring over 250 peer-reviewed technical publications, encompassing more than 95 journal articles and over 100 conference papers, and presenting more than 140 technical presentations in the realm of pavement/geosystem and transportation infrastructure engineering. Dr. Kim's expertise and dedication to his field have been recognized with several awards, including the 2020 FAA PEGASAS Jimenez Faculty/Researcher Award and the 2021 ISU Professional and Scientific Excellence Award, among others, underscoring his substantial impact on pavement engineering and transportation infrastructure system research.

Halil Ceylan, Dist.M.ASCE, is a Pitt-Des Moines, Inc. Endowed Professor specializing in Transportation Geotechnical/Materials Engineering and Intelligent Infrastructure Engineering in the Department of Civil, Construction, and Environmental Engineering (CCEE) at Iowa State University (ISU). Dr. Halil Ceylan serves as the Founding Director of the Program for Sustainable Pavement Engineering and Research (PROSPER) at the ISU Institute for Transportation and the ISU Site Director for Partnership to Enhance General Aviation Safety, Accessibility and Sustainability (PEGASAS) Federal Aviation Administration (FAA) Center of Excellence on General Aviation. Prof. Ceylan holds a Bachelor of Science degree (Dokuz Eylul University 1989), two Master of Science degrees (Dokuz Eylul University 1993, University of Illinois at Urbana-Champaign 1995), and a doctorate (University of Illinois at Urbana-Champaign 2002), all in civil engineering. Since 2002, Prof. Ceylan has taught courses in pavement analysis and design, design of concretes covering portland cement concrete and asphalt cement concrete, geotechnical engineering, and senior design to as many as 3,000 undergraduate and graduate students.

Prof. Ceylan has extensive experience in the area of transportation/geo-infrastructure engineering and has pioneered innovative research and techniques for achieving "Smart, Sustainable, Durable, and Resilient Geosystems and Transportation Infrastructure Systems." Throughout his career, he has been involved with over 135 research projects, worth more than $25 million project funds, serving as the principal investigator or co-principal investigator; these projects have been sponsored by the Federal Aviation Association, Federal Highway Administration, National Cooperative Highway Research Program, National Science Foundation, Second Strategic Highway Research Program, Portland Cement Association, various state departments of transportation (DOTs) and research boards, including the Iowa DOT and Iowa Highway Research Board, among others. Prof. Ceylan has authored and co-authored over 420 peer-reviewed publications, including more than 155 journal articles, more than 170 conference papers, 6 edited books, 4 invited book chapters, and more than 75 technical reports, among others. He is a leader and an avid technical presenter, having delivered over 400 presentations, including 150+ invited talks and several keynote lectures, taught/organized over 15 short courses and workshop events, and presided over 45 technical sessions, tracks, and conferences, including serving as the organizing/conference chair or co-chair for three national/international level conferences. Prof. Ceylan has supervised/co-supervised more than 70 graduate students and more than 15 postdoctoral research associates, research staff, and visiting scholars from diverse and multicultural backgrounds. He has received over 25 awards, including the 2022 Class of ASCE Distinguished Member, the 2021 ASCE James Laurie Prize, and the 2022 University of Illinois Alumni Achievement Award.

System and Model Robustness for Hydrosystems in the Era of the Fourth Industrial Revolution

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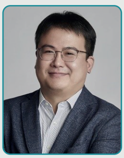
Robustness is defined as a system's ability to persist its functionality under disturbances. A robust water distribution system (WDS) should be able to provide consistently sufficient pressures under various conditions (e.g., fire flow and pipe break conditions). The identical global optimal solution could be found in different independent optimization trials by a robust metaheuristic optimization algorithm (MOA). This study reviews the state-of-the-art design, operational, and management approaches to improve hydrosystems' robustness. Reviewed studies range from robustness-based multiobjective optimal design of WDS, ensemble convolutional neural network for robust pipe burst detection, and robust scenario planning of urban drainage system to novel MOA and machine learning models for robust search and problem solving. Finally, strategies for improving system and model robustness are summarized to respond to the era of the fourth industrial revolution.



Donghwi Jung is an Associate Professor in the School of Civil, Environmental and Architectural Engineering, Korea University. Donghwi Jung received his Bachelor and Master's degree in Civil, Environmental and Architectural Engineering from Korea University in 2009 and 2011, respectively. In 2013, he received Ph.D. in Civil Engineering and Engineering Mechanics from University of Arizona.
His research interests lie in the interdisciplinary area of water system optimization, with particular emphasis on system resilience and robustness. The ultimate contribution of his work in this area is toward allowing hydrosystems (water distribution system, urban drainage system, etc.) to maintain their performance and to sustain the availability of water during and after natural and human-made disturbances (pipe bursts, population increases, and climate changes).

Advancing Real-Time In-Situ Environmental Monitoring Using Autonomous Unmanned Vehicles

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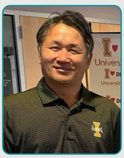
The ongoing urban expansion, land use change, and economic growth continue to impact the water quality in Idaho's aquatic systems, including rivers, lakes, and reservoirs. While traditional methods of monitoring water quality play a significant role in informing the water community, there remains a need for further exploration to improve real-time monitoring and sampling of water quality for public safety. To address this, unmanned vehicle platforms, including unmanned aerial vehicles (UAVs) and unmanned surface vehicles (USVs) are being employed. These technologies are enhanced by cloud-based data sharing systems by utilizing Long-term Evolution (LTE) communication protocols. During the presentation, the author will demonstrate the advantages and disadvantages of these technologies and consider potential opportunities that could be applied to promote environmental stewardship by engaging citizen-scientists, thereby broadening their impact for public safety. Overall, the integration of UAV and USV platforms is poised to make a substantial contribution to environmental conservation and research in aquatic ecosystems in the forthcoming years.



Jae Ryu, Ph.D., P.E., is an associate professor of water resources engineering at the University of Idaho (UI). He received his Ph.D. in 2006 from civil and environmental engineering department at the University of Washington, Seattle. Since he joined UI as a faculty member, he also worked at the U.S. Air Force Academy (USAFA) to advance his research program using fast-moving technology, such as Unmanned Aerial System (UAS, also known as drone). He is the founder of Idaho Drone League (iDrone) and Interstate Drone League (iDrone National) to stimulate America youth (6th – 12th grade students) by learning basic concepts in automatic control, robotics and UAS system. Dr. Ryu hosted iDrone Summer Camp (iDrone Camp) offline to catalyze a hands-on STEM-based learning across Idaho since 2018. He continues to offer hands-on drone camps online (iDrone Online) via virtual e-learning platforms since the global pandemic (COVID-19). For more information, please visit at: *https://www.idroneprogram.org.*

Artificial Electric Field Algorithm for Training Multilayer Perceptron Models

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Artificial Electric Field Algorithm (AEFA) is a recent metaheuristic which is inspired from the electrostatic force theory. In this algorithm the candidate solutions are considered as charged particles which can move under the influence of an artificially generated electric field. The fundamental concept of the attraction and repulsion of charged particles plays a major role to put an intelligence into these charged particles. This artificially created intelligence can be harnessed and many real-life challenging problems can be solved using this algorithm. There are many variants of AEFA available in the literature to address different types of optimization problems such as constrained, unconstrained and combinatorial optimization problems etc. Training multilayer perceptron model requires an optimal value of weights and bias, some times gradient based optimization algorithm do not yield an optimal parameter value which results in a poor training of the model. To overcome this issue the use of metaheuristics for training neural networks is becoming very popular. In particular AEFA is used for training multilayer perceptron models on several real-life data sets and the results are found very good and better than other heuristics methods and gradient based optimizers. The promising results of AEFA for training multilayer perceptron models gives a good scope for its application in other areas such as civil and environmental engineering problems.

Anupam Yadav is an Associate Professor at the Department of Mathematics, Dr. B. R. Ambedkar National Institute of Technology Jalandhar, India. His research area includes numerical optimization, soft computing, and artificial intelligence, he has more than ten years of research experience in the areas of soft computing and optimization. Dr. Yadav has done Ph.D. in soft computing from the Indian Institute of Technology Roorkee and he worked as a research professor at Korea University. He has published more than twenty-five research articles in journals of international repute, has published more than fifteen research articles in conference proceedings. Dr. Yadav has authored a textbook entitled ¨An introduction to neural network methods for differential equations. He has edited several books which are published by AISC, LNDECT Springer Series. Dr. Yadav have been the General Chair, Convener and member of the steering committee of several international conferences. He is a member of various research societies.

Artificial Intelligence for Advancing Water Treatment Research and Development

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Advancing research and development in water treatment is essential for securing the water, energy, and carbon (WEC) lifeline. However, the acquisition of clean water can be energy-intensive and can impact carbon emissions. Therefore, achieving sustainability in the WEC lifeline needs innovative approaches that go beyond traditional methods to enhance the water infrastructure performance. The dynamic growth in water treatment research underscores the potential of artificial intelligence (AI) in extracting valuable insights from published data. Unlike traditional models facing challenges in handling complex non-linear relationships, AI offers an effective approach by learning from the data pattern. Though not inherently mechanistic, AI models complement traditional methods to elucidate the complexities of environmental systems and design effective solutions. This lecture provides a review of AI applications in water treatment research and development, with a focus on performance prediction, key variables identification, and system optimization for desired water quality output. Furthermore, challenges and future prospects are discussed to underscore the promising role of AI in the field of water treatment.

Nurul Alvia Istiqomah is a lecturer in the Department of Civil and Environmental Engineering, Universitas Gadjah Mada. She earned her Bachelor's degree in Environmental Science and Engineering from Universitas Airlangga in 2016. Subsequently, in 2019, she obtained a Master's degree in Environmental Engineering from National Chiao Tung University. In 2023, she completed her Ph.D. in Civil, Environmental, and Architectural Engineering from Korea University.
Her research revolves around sustainable materials development for water, wastewater, and air remediation. Her recent research areas also include predictive modeling using artificial intelligence approaches in heterogenous catalytic water treatment processes.