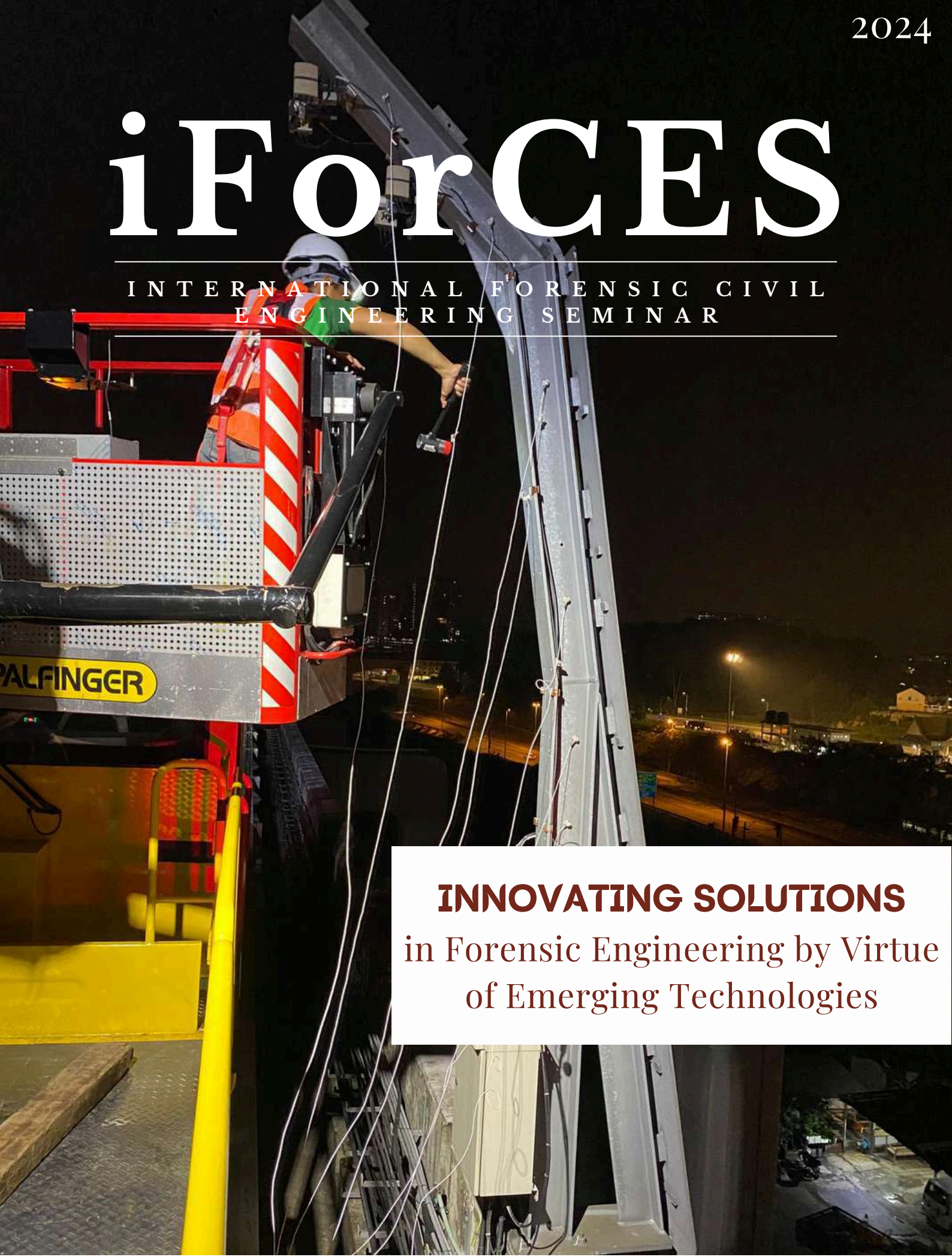
2024

iForCES

INTERNATIONAL FORENSIC CIVIL ENGINEERING SEMINAR



INNOVATING SOLUTIONS

in Forensic Engineering by Virtue of Emerging Technologies

UTM UNIVERSITI TEKNOLOGI MALAYSIA

ISIIC INSTITUTE FOR SMART INFRASTRUCTURE AND INNOVATIVE CONSTRUCTION

UTM UNIVERSITI TEKNOLOGI MALAYSIA

FORENSIC ENGINEERING CENTRE

Program Book

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	Associate Prof. Ts. Dr. Izni Syahrizal Ibrahim *(Director, Institute of Smart Infrastructure & Innovative Construction; Acting Director, Forensic Engineering Centre)*

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MAIN OFFICE

Forensic Engineering Centre,
Institute for Smart Infrastructure and Innovative Construction
Level 2, Block D04, Faculty of Civil Engineering
Universiti Teknologi Malaysia
81310, Johor Bahru
Johor Darul Ta'zim
Malaysia

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CLOSURE

| fec@utm.my

| +60 7 553 1931

| +6 017 654 4297

https://research.utm.my/fec

Prof. Datuk Ir. Ts. Dr.
Ahmad Fauzi Ismail
Vice Chancellor
Universiti Teknologi Malaysia

WELCOME NOTE

Assalamualaikum wm. wbt, Salam Sejahtera, and Salam UTM Sanjungan Bangsa.

It is my great pleasure to welcome you to the International Forensic Civil Engineering Seminar 2024 (iForCES'24). I would like to extend my heartfelt congratulations to the Forensic Engineering Centre (FEC) and the Institute for Smart Infrastructure and Innovative Construction (ISiiC) of Universiti Teknologi Malaysia (UTM) for their excellent efforts in organizing this event.

The FEC, as a center of excellence at UTM, has played a crucial role in advancing research, consultancy, and professional training in forensic engineering. Its commitment to knowledge exchange and professional growth is commendable, and iForCES'24 stands as a reflection to that dedication.

iForCES'24 offers a valuable platform for professionals, including engineers, facility managers, auditors, enforcement officers, academics, researchers, and students. This seminar not only encourages the exchange of ideas but also helps build collaborations and networks that are vital for the industry's progress. The theme, "Innovating Solutions in Forensic Engineering by Virtue of Emerging Technologies" is timely and relevant to the evolving needs of the field.

I am particularly impressed by the range of insightful topics to be covered, including structural damage, landslides, geotechnical issues, structural health monitoring, and recommendations for repair and rehabilitation. These subjects are crucial in addressing some of the most pressing challenges in our field today, and I believe the knowledge shared here will be invaluable in preventing or mitigating similar issues in the future.

I hope this seminar provides a rewarding experience for all of you. May the discussions and insights contribute to the continued advancement of forensic civil engineering. Thank you for your support, and I wish you all a productive and beneficial seminar.

WELCOME NOTE

Associate Prof. Dr. Ts. Izni Syahrizal Ibrahim

Director

Institute of Smart Infrastructure and Innovative Construction

As the Acting Director of the Forensic Engineering Centre (FEC), Institute for Smart Infrastructure and Innovative Construction (ISiiC), Faculty of Civil Engineering, Universiti Teknologi Malaysia (UTM), it is both an honour and a privilege to welcome you to the International Forensic Civil Engineering Seminar 2024 (iForCES '24). This seminar which is held every year, has become a cornerstone in the field of Forensic Civil Engineering Investigation, and I am delighted to see its continued growth as we gather here once again.

This year's theme, "Innovating Solutions in Forensic Engineering by Virtue of Emerging Technologies," highlights the importance of staying at the forefront of technological advancements in our discipline. From artificial intelligence (A.I) and advanced simulation tools to the latest developments in material science, emerging technologies are transforming how we investigate, analyze, and solve complex engineering problems. In this seminar, we aim to explore how these innovations can be applied to forensic investigations, improving the accuracy, efficiency, and sustainability of our practices.

The Forensic Engineering Centre (FEC) has always been dedicated to fostering excellence in forensic engineering research, consultancy and education, and we are proud to host this international seminar as a platform for sharing knowledge, exchanging ideas, and fostering collaborations. The insights and forum discussions that will take place here over the next few days will not only contribute to the advancement of forensic engineering but also help in shaping safer, more resilient Civil Engineering infrastructure for future generations.

I would like to extend my heartfelt thanks to the organizing committee, the distinguished speakers, and all participants for their dedication and enthusiasm in making this event possible. Your expertise and contributions are invaluable, and I have no doubt that iForCES '24 will inspire innovative solutions to the pressing challenges we face in our field.

Once again, welcome to iForCES '24. I wish you a productive and enriching experience as we explore the exciting intersections of forensic engineering and emerging technologies, especially in the area of Civil Engineering.

Assalamualaikum wbt and good day to everyone,

It is a privilege to begin by thanking Allah S.W.T for giving us the opportunity to organize the International Forensic Civil Engineering Seminar 2024 (iFORCES'24). I am truly delighted to welcome all participants to this prestigious seminar. This year marks the 6th time the UTM Forensic Engineering Centre has hosted the event, and we are proud to collaborate with the IEM Sarawak Branch, with the valuable support of BE Sarawak, NL Scientific, and VRG Dinamik Sdn Bhd.

The theme for this year's seminar, "Innovating Solutions in Forensic Engineering by Virtue of Emerging Technologies," underscores the critical role that advanced technologies play in forensic investigations today. As our civil infrastructure ages and new challenges arise, forensic engineering must evolve to meet these demands. This seminar will serve as a platform to discuss innovative research, cutting-edge technologies, and practical solutions that will not only ensure structural integrity but also promote sustainability and effective lifecycle management.

It is especially heartening to see such a diverse gathering of professionals, including engineers, consultants, contractors, facility managers, legal experts, students, and academicians. The broad range of expertise represented here promises fruitful exchanges of ideas and the potential for meaningful collaborations. These interactions are essential for pushing the boundaries of forensic engineering and addressing the complex challenges our industry faces.

To all our valued participants, I extend my heartfelt gratitude for your involvement and contributions, which have helped make this seminar a reality. I am confident that our distinguished speakers will provide deep insights and inspire thought-provoking discussions that will enrich your experience at iFORCES'24. Their knowledge and expertise will offer a global perspective on the latest developments in forensic engineering, ensuring a truly comprehensive and enriching seminar.

I sincerely hope that this event serves as an inspiring and productive opportunity for all attendees, leading to new ideas, partnerships, and innovations that will shape the future of forensic engineering. Thank you

Dr Khairul Hazman Padil

Chairman

iForCES'24

WELCOME NOTE

About iForCES'24 ...

At iForCES'24, attendees will benefit from presentations delivered by experienced industry professionals and renowned academics, who will discuss a wide range of case studies and forensic engineering research projects, ensuring a comprehensive exploration of the field.

The Forensic Engineering Centre (FEC), Institute for Smart Infrastructure & Innovative Construction (ISIIC), and Faculty of Civil Engineering, UTM are proud to host the International Forensic Civil Engineering Seminar 2024 (iForCES'24), taking place on 15 and 16 October 2024 at the Imperial Hotel, Kuching.

This seminar offers a premier platform for professionals, including practicing engineers, consultants, contractors, facility managers, legal experts, students, and academicians, to expand their knowledge and skills in forensic civil engineering.

As civil infrastructure continues to age, and urbanization accelerates, the need for expert forensic investigation becomes increasingly critical. Structural failures, rehabilitation, and maintenance challenges demand a deeper understanding of the causes and prevention of such issues. iForCES'24 addresses these needs by sharing the latest advancements, case studies, and innovative research in forensic engineering, emphasizing safety, sustainability, and structural lifecycle management.

Program Schedule

15th October 2024

DAY 1

0800-0815	REGISTRATION
0815-0900	OPEN CEREMONY
0900-0930	PHOTO SESSION AND TEA BREAK
0930-1230	SESSION 1: GEOTECHNICAL FORENSICS AND GROUND INVESTIGATION
	SURVEYING TECHNIQUES FOR SLOPE FAILURE INVESTIGATION: A HEURISTIC APPROACH
	IN-PEAT GEOMECHANICAL MONITORING METHOD UNDER ACTUAL ROAD EMBANKMENT
	GEOTECHNICAL INVESTIGATION OF A 45 M HIGH SOIL NAIL SLOPE FAILURE
1230-1300	SESSION 1 FORUM DISCUSSION
1300-1400	LUNCH BREAK
1400-1700	SESSION 2: ADVANCED NDT FOR FORENSIC INVESTIGATION
	UNVEILING THE VERSALITY OF GROUND PENETRATING RADAR TECHNOLOGY
	THE ART OF IMPULSE RADAR FOR RESILENT STRUCTURE
	DRONE TECHNOLOGY FOR VISUAL INSPECTION AND 3D MAPPING FOR DIGITAL TWINNING
1700-1730	SESSION 2 FORUM DISCUSSION
1730	TEA BREAK & END OF DAY 1

DAY 2

0830-1030	SESSION 3: TECHNOLOGIES FOR STRUCTURAL HEALTH MONITORING
	NATIONWIDE IOT SHM NETWORK FOR BRIDGES AND VIADUCTS: THE ITALIAN CASE STUDY
	STRUCTURAL INTEGRITY ASSESSMENT USING VIBRATION BASED DAMAGE DETECTION TECHNIQUE
1030-1045	SESSION 3 FORUM DISCUSSION
1045-1100	TEA BREAK
1100-1300	SESSION 4: ADVANCED MATERIALS FORENSICS
	QUANTIFYING DEFECTS IMPACT IN CONCRETE ELEMENTS DURING SERVICE THROUGH SIMULATION-BASED ANALYSIS
	MATERIALS FOR MARINE STRUCTURES
1300-1315	SESSION 4 FORUM DISCUSSION
1315-1430	LUNCH BREAK
1430-1600	CLOSING CEREMONY
1600	TEA BREAK & END OF SEMINAR

16th October 2024

Surveying Techniques for Slope Failure Investigation: A Heuristic Approach

DR RADZUAN

Senior Lecturer
Faculty of Civil Engineering, UTM

Sr. Ts. Dr. Radzuan Sa'ari earned his Certificate in Land Surveying in 1990 and his Diploma in Land Surveying in 1994 from Politeknik Ungku Omar (PUO). He completed his B.Sc. in Land Surveying from the Faculty of Geoinformation and Real Estate (FGHT) at Universiti Teknologi Malaysia (UTM) in 1997, followed by an M.Sc. in Land Surveying from the same faculty in 2002. In 2016, he obtained his Ph.D. in Civil Engineering from UTM, focusing on the applications of Digital Close-Range Photogrammetry and Digital Image Processing in structural deformation analysis. Dr. Radzuan began his academic career at UTM as a Research Assistant in 1997 within Faculty of Geoinformatics and Real Estate. He later served as a Tutor and Lecturer in the Faculty of Civil Engineering in 1999 and 2002, respectively. Since 2017, he has held the position of Senior Lecturer in the Department of Water and Environmental Engineering at the Faculty of Civil Engineering, UTM. Before joining academia, Dr. Radzuan worked at Hisham Isa GeoTeam Sdn. Bhd. (formerly Jurukur Malinja Sdn. Bhd.) as an Assistant Land Surveyor and Assistant Hydrographic Surveyor from 1991 to 1992. He then worked as a freelance Hydrographic Surveyor from 1992 to 1994, engaging in offshore construction and surveying projects in the Southeast Asian region with Stolt Comex Seaway S.A. and PT Komaritim. His research interests encompass surveying and mapping applications within Civil Engineering, including Laboratory Experiments, Digital Image Processing, Engineering Surveying, Deformation Monitoring, Hydrographic Surveying, GNSS Surveying, Digital Close-Range Photogrammetry, and Aerial Photogrammetry using Drones/UAVs.

Synopsis

In late December 2022, during the monsoon season, a slope failure occurred near the water tank at Kolej Tun Ghafar Baba (KTGB) within Universiti Teknologi Malaysia (UTM) in Johor Bahru. This incident raised urgent concerns due to its proximity to the water supply for KTGB residents and neighboring colleges in the UTM campus. Recognizing the need for prompt action, the Director of Works enlisted the Geotechnical Research Group from the Faculty of Civil Engineering to investigate the cause of the failure and propose effective remediation measures. To gather essential topographical data and cross-sectional profiles. The research group collaborated with the Surveying Unit, together, they conducted field investigations in the affected area, utilizing advanced measurement techniques such as digital auto levels, total stations, Global Navigation Satellite Systems (GNSS), Terrestrial Laser Scanners, and Unmanned Aerial Vehicles (UAVs) to ensure comprehensive and precise surveying results. In addition to these efforts, the geotechnical team also utilized the site investigation as a valuable educational training opportunity for academic staff, technical personnel, and selected civil engineering undergraduates. The fieldwork included various geotechnical field data collection activities, such as soil boring, Standard Penetration Tests (SPT), resistivity surveys, Mackintosh tests, geological mapping, and slope stability analysis. Through a thorough analysis of the collected data, the geotechnical team successfully identified the underlying causes of the slope failure and proposed recommendations for effective slope repair, ensuring the safety and stability of the area for the future.

PROGRAM

In-Peat Geomechanical Monitoring Method Under Actual Road Embankment

Synopsis

This study explores the groundbreaking 'in-peat' geomechanical monitoring technique being applied beneath a road embankment in Sarawak, Malaysia. As part of the construction of a major 236 km second trunk road, the embankment, measuring 24 meters wide and 2 meters high, is built over a challenging foundation of approximately 5 meters of peat and soft clay. The peat varies in classification from fibric (H4) to hemic (H8), with low undrained shear strength values. The innovative 'in-peat' method allows for the real-time monitoring of vertical and horizontal stress, pore water pressure, and settlement within the peat layer itself, using buried sensors. This data is invaluable for understanding the behavior of peat under the significant load of the embankment, both during and after construction. The ongoing monitoring is expected to provide insights that will validate current conceptual models of peat behavior, contributing to the advancement of soil mechanics and ensuring the stability of future infrastructure projects built on similar challenging terrain. The installation and monitoring of the sensors, which are functioning successfully. Early data shows that the sensors are providing accurate readings in line with the actual site conditions, marking a crucial step in enhancing our understanding of geomechanical responses in peat.

DR. LEE LIN JYE

Senior Principal Assistant Director
Slope and Forensic Branch,
Malaysian Public Works Department

Dr. Lee Lin Jye was born in Kuching, Sarawak and developed a keen interest in engineering from an early age. He pursued his academic ambitions at Universiti Teknologi Malaysia (UTM), where he obtained a diploma in Civil Engineering in 1996. Continuing his education, he earned a Bachelor's Degree in Civil Engineering from Universiti Malaysia Sarawak (Unimas) in 1998. In 1999 Dr. Lee Lin Jye began his professional career as a road design engineer at the Road Branch, Headquarters of the Public Works Department (JKR), where he specialized in various aspects of road design, including Geometric Design, Pavement Design, Drainage Design, and Geotechnical Design. His expertise quickly became evident, leading to a transfer in 2004 to JKR Betong as a Road Engineer, where he assisted the Divisional Engineer in project management and supervision for road and bridge projects within the Betong Division. In 2009, he enhanced his qualifications by obtaining a Master of Science in Construction Contract Management from UTM. That same year, he returned to the Headquarters of JKR, taking on a new role in the Geotechnical and Structural Engineering branch. There, he was responsible for planning, reviewing, and updating development plans for various wharf projects. Demonstrating a commitment to continuous improvement, Dr. Lee Lin Jye obtained his PhD in 2018 from University Malaysia Sarawak (UNIMAS). Following this achievement, he transferred to the Investigation Branch at JKR HQ, where he contributed to the planning and development of a new Geotechnical Unit. Today, Dr. Lee Lin Jye heads the Slope and Forensic Branch at JKR HQ, leveraging his extensive experience and expertise to address complex engineering challenges and contribute to the advancement of civil engineering practices in Sarawak.

Geotechnical Investigation of a 45m High Soil Nail Slope Failure

IR. CHOW CHEE MENG

Director
G&P Geotechnics

Ir. Chow Chee Meng obtained his Bachelor of Engineering (Civil) from University of Malaya and started his career with G&P Geotechnics, an independent consulting company specialising in Geotechnical and Geo-Environmental Engineering before joining Technip, the largest integrated offshore and onshore engineering contractor in South East Asia for the design and construction of hydrocarbon field development, oil refining, gas processing, petrochemicals and industrial plants and facilities. He has written numerous papers and given lectures on engineering subjects ranging from R&D to geotechnical engineering in international and local conferences and journals and his research interests includes deep excavation, jack-in pile, piled raft and soil nails. Throughout his career as a geotechnical engineer, he was fortunate to be involved in a number of award-winning projects such as Bandar Botanic, Klang (ACEM Silver Award of Merit), Sg. Damansara Flood Mitigation (ACEM Gold Award of Special Merit) and was awarded the Outstanding Performance Award from Sunrise Berhad for geotechnical consultancy. He is currently the Director of G&P Geotechnics after re-joining them in 2005 and is actively involved in various types of projects such as high-rise development, major infrastructures such as MRT/LRT/BRT/HSR and major petrochemical plants. He is a committee member of the Geotechnical Engineering Technical Division of the Institution of Engineers, Malaysia (IEM) from 2008 to 2013. He is currently serving the Board of Engineers, Malaysia (BEM) as Investigating Committee Member on Professional Practice (since 2014), Member of the Industry Advisory Panel (IAP) for the Faculty of Engineering and the Built Environment, SEGi University (since 2016), Member of the Industry Advisory Board (IAB) for Bachelor of Civil Engineering with Honours Programme, UCSI University (since 2021), Committee Member of Malaysian Geotechnical Society (since 2021) and Editorial Reviewer of the Geotechnical Engineering Journal of the SEAGS & AGSSEA (since October 2021).

Synopsis

Slope failures and landslides is a perennial problem in Malaysia especially during monsoon season and it is important for the engineering fraternity to learn from previous failures to ensure public safety and minimize risk associated with slope engineering. In failure investigation, various causal factors have to be considered and it is important that the investigation covers both conditions and processes, rather than just the triggering factor. In this presentation, approaches adopted and experiences gained from the investigation of a 45m high soil nail slope failure will be shared which includes discussion on geological features/discontinuities, rainfall, construction and geotechnical assessment/design of the soil nail slope. Some common issues related to design and construction of soil nail slope, especially for high and steep slope will also be discussed.

PROGRAM

Unveiling the Versatility of Ground Penetrating Radar Technology

Synopsis

Ground Penetrating Radar (GPR) technology is a non-destructive testing (NDT) method that is highly versatile and non-invasive geophysical tool that uses radar pulses to detect and map subsurface structures. It operates by transmitting electromagnetic waves into the ground and capturing the reflected signals from different materials or objects beneath the surface. GPR's flexibility and precision make it invaluable across multiple industries, including archaeology, construction, environmental science, and forensics. In archaeology, GPR allows researchers to discover buried artifacts, ancient structures, and graves without excavation, preserving the site's integrity. Similarly, civil engineers use GPR for utility mapping, identifying the location of underground pipes, cables, and other infrastructure before digging, reducing the risk of costly damages. In the construction industry, GPR is employed for concrete inspection, detecting voids, cracks, and the placement of rebar to ensure structural integrity. The environmental sector also benefits from GPR's capabilities, as it allows for the mapping of subsurface features like sinkholes, cavities, and landslide-prone areas, enabling better land-use planning and risk mitigation. This application is crucial for regions vulnerable to environmental hazards, helping to prevent disasters by identifying potential risks early and guiding informed decision-making for sustainable development. GPR's non-destructive nature is equally valuable in forensic investigations, enabling law enforcement to locate hidden objects, unmarked graves, or evidence buried beneath the surface. The ability to produce real-time imaging without disturbing the area under study makes GPR an ideal tool for sensitive investigations. As technology advances, the accuracy, depth, and resolution of GPR continue to improve, expanding its applicability and enhancing its effectiveness in a wide range of fields.

TENGKU SARAH TENGKU AMRAN

Research Officer
Agensi Nuklear Malaysia

Tengku Sarah Tengku Amran received the BSc (Hons) in Engineering Physics and the MSc degree in Solid State Physics with the School of Physics of University Sains Malaysia, Penang. Currently working as a Research Officer in Agensi Nuklear Malaysia, Bangi under Non-Destructive Testing for Material Structure Integrity group at Industrial Technology Division. Nearly a decade experience in Non-Destructive Testing (NDT) field focusing in Ground penetrating radar (GPR) and radiography testing (RT). Hold certificate NDT level 2 Radiography Testing for welded component and had involved in many forensic investigations using GPR technique. Her research work is focused on assessment of civil engineering infrastructures and forensics investigation using Ground Penetrating Radar (GPR). She has been involved in several research projects as team leader such as Development of new data correction procedure for monitoring soil condition using Ground Penetrating Radar (GPR) and Nuclear Density Gauge (NDG) and also Ground Penetrating Radar (GPR) Testing for Water Leakages project. She has served as project member for corporate sosial responsibility (CSR) project utilizing GPR techniques in locations like Batang kali Tragedy, Ops Reunite and Ops Te Auraki a joint mission with the army to conduct exhumation and repatration of the remains of Commonwealth soldiers. She actively participates in numerous innovation competions and has won multiple gold awards since 2021. She was the recipient of an award best of the best category professional in National Innovation & Invention Competion 2022 (NICE 2022) for invention of GPR Roadscan:Portable Mounting System. She has authored and co-authored about more than 30 publications in international journals and conference proceedings and served as reviewer in several international journals.

The Art of Impulse Radar for Resilient Structure

ASSOC. PROF. TS. DR. MUHD NORHASRI MUHD SIDEK

Principal Researcher
Institute for Infrastructure Engineering and Sustainabble Management (IIESM),
Universiti Teknologi MARA Malaysia

Associate Professor Ts. Dr. Muhd Norhasri Muhd Sidek is a Principal Researcher and Associate Professor of the Institute for Infrastructure Engineering and Sustainable Management (IIESM) and School of Civil Engineering, Universiti Teknologi MARA (UiTM) Malaysia. Dr Muhd Norhasri obtained his Diploma in Civil Engineering from Institute Technology MARA (ITM), Bachelor of Science in Civil Engineering (UiTM), Master of Science of Civil Engineering (USM) and Doctor of Philosophy in Civil Engineering (UiTM). He started his career in Civil Engineering back in 2001 as Site Engineer at Tabung Haji Technologies (THT) and later on been offered to pursue his career as a lecturer at Faculty of Civil Engineering UiTM from 2002 until present. His career in UiTM started at UiTM Perlis then to UiTM Pulau Pinang and presently at UiTM Shah Alam. His research interest are concrete, sustainable materials, Nano materials, Ultra High Performance Concrete (UHPC) and non destructive test (NDT) for building materials. Currently, he is a registered Professional Technologist (Ts) from Malaysian Board of Technology (MBOT) and currently an active reviewer for Construction and Building Materials, Elsevier since 2016 until present. Currently he is appointed as Deputy President for Concrete Society Malaysia (CSM) and actively involved as panel for CIDB and JPK competency progarmme. Presently he is appointed as a consultant for Nattest Laboratory and NL Scientific which collaborated on construction and material testing. His vast experience on NDT testing especially for infrastructure monitoring and inspection and involved directly with government and private agency in Malaysia such as JKR, PLUS, JPS and others.

Synopsis

Non-destructive testing (NDT) plays a critical role in civil engineering by enabling the assessment of material and structural integrity without causing damage. It ensures safety, quality control, and durability in bridges, buildings, and roads. Techniques like ultrasonic testing, ground-penetrating radar, and infrared thermography allow engineers to detect defects, cracks, voids, and corrosion in materials like concrete and steel. NDT helps in the early detection of potential failures, allowing for timely maintenance and reducing repair costs. It also aids in evaluating existing structures' longevity, ensuring they meet safety standards. By preserving the structure during testing, NDT supports sustainable practices and minimises service disruption, making it a valuable tool in modern civil engineering projects.

Drone Technology for Visual Inspection and 3D Mapping for Digital Twinning

Synopsis

This presentation delves into the transformative role of drone technology in Non-Destructive Testing (NDT) solutions. Attendees will gain insights into advanced visual inspection techniques and ultrasonic testing conducted via drones, highlighting their effectiveness in enhancing safety and operational efficiency. The session will also showcase the development of 3D digital twins, offering data visualization and analysis for asset monitoring and maintenance. We will illustrate how these innovative methods address the unique challenges of inspecting complex structures in demanding environments, ultimately paving the way for improved inspection practices in critical infrastructure.

MR. ELINGEISHWARAN GUNASEGARAN

Senior Business Development Executive
Terra Drone Technology Malaysia

Elingeishwaran Gunasegaran is a highly skilled Senior Business Development Executive with a strong background in mechanical engineering and project management. Graduating with a Bachelor of Engineering with Honours in Mechanical Engineering from the University of Nottingham, he has applied his expertise across industries such as drone technology, artificial intelligence, and agriculture. Currently working at Terra Drone Technology Malaysia, Elingeishwaran has demonstrated exceptional abilities in strategic planning, market research, client relationship management, and successful project execution. His notable projects include negotiating key distributorship agreements, managing drone data capture initiatives for MISC Berhad, and leading AI-based safety solutions for major clients like Petronas and BASF Petronas Chemicals.

Nationwide IoT SHM Network for Bridges and Viaducts: the Italian Case Study

DR FRANCESCA BRIGHENTI

International Sales Director
Nplus s.r.l

Dr Francesca Brighenti holds a degree in Civil Engineering from the University of Trento, Italy, where she completed a master's thesis on Structural Health Monitoring (SHM) as part of a national project to establish monitoring standards for Italy's largest highway operator. She has since expanded her expertise through research and collaborations on national and international SHM projects during her research fellowship at the University of Trento and as an SHM specialist with Nplus s.r.l and Ikubed s.r.l. (Italy). Currently, Dr. Brighenti is pursuing an Industrial PhD at the University of Trento, funded by Nplus, where she also holds the position of International Sales Director. Her research and professional activities focus on developing Decision Support System tools for infrastructure management, in collaboration with international research institutions and major Italian infrastructure operators. Her research encompasses risk assessment, asset management, SHM, and sensor technology for civil infrastructure. Dr. Brighenti has authored several scientific publications and has been a guest speaker at numerous national and international conferences.

Synopsis

Globally, infrastructure monitoring is becoming increasingly important, especially as older structures in Europe show signs of fragility and emerging countries face growing demands. With rising traffic and the impacts of climate change, bridges and viaducts require enhanced attention. Effective monitoring of both new and existing bridges gives road managers vital insights into infrastructure performance, allowing for timely interventions that ensure safety and usability. Efficient resource management for maintenance and structural oversight brings substantial benefits in terms of durability, safety, investment returns, and the reputation of road operators and nations. Following the tragic collapse of the Morandi Bridge, Italy's Ministry of Infrastructure and Transport has invested significantly in advanced management measures. These include issuing preliminary risk classification guidelines, implementing bridge management system (BMS) software, and deploying Structural Health Monitoring (SHM) technologies across the country. This presentation will explore Italy's innovative approaches to structural monitoring for bridges and viaducts, highlighting the country's leading work in predictive maintenance using integrated IoT systems. Italy's advancements in SHM can serve as a model, demonstrating the extensive benefits of this technology. The session will also cover the integration of SHM within Bridge Management, showcasing how these innovations can transform infrastructure maintenance. Detailed case studies will illustrate the practical benefits and effectiveness of SHM integration, providing insights into improved infrastructure resilience and management efficiency.

Structural Integrity Assessment using Vibration- Based Damage Detection Technique

Synopsis

Structural integrity assessment is essential for ensuring the safety and reliability of engineering structures, especially in civil, aerospace, and mechanical fields. One effective method for assessing the health of a structure is through vibration-based damage detection techniques, which utilize changes in the dynamic characteristics of a structure—such as natural frequencies, mode shapes, and damping ratios—to identify and localize damage. Damage in a structure, whether caused by material fatigue, environmental conditions, or overloading, leads to alterations in its stiffness, mass, and damping properties. These alterations, in turn, affect the structure's vibrational response. By monitoring these changes, engineers can detect the presence of cracks, corrosion, or other forms of deterioration early, preventing catastrophic failures. Vibration-based techniques typically involve the use of sensors, such as accelerometers, to capture the vibration data from a structure during its operational state. The collected data is then analyzed using various signal processing and statistical methods, including modal analysis, frequency response functions (FRFs), finite element model updating or advanced algorithms such as the machine learning techniques. These methods help determine the relationship between the changes in the dynamic response and the corresponding damage. One of the major advantages of this technique is its non-invasive nature, meaning it does not require direct access to the damaged areas of the structure, allowing for continuous monitoring without the need for disassembly or interruption of the structure's operation. This makes it particularly useful for large-scale or complex structures, such as bridges, buildings, or aircraft. In conclusion, vibration-based damage detection is a promising tool for structural integrity assessment, providing a proactive and cost-effective solution to maintain the safety and durability of critical infrastructures. By identifying damage early, it contributes to extending the life span of structures and preventing severe structural failures.

DR. YON KONG CHEN

Director
VRG Dinamik Sdn Bhd

Dr. Yon Kong Chen (KC) is a civil engineer specializing in structural health monitoring and dynamic finite element analysis. He holds a PhD in Civil Engineering from Universiti Teknologi Malaysia (UTM), where he completed his degree in 2022, following his Bachelor's and Diploma degrees in Civil Engineering from the same university. Throughout his academic journey, he has developed extensive expertise in modal analysis, structural health monitoring, pipeline condition monitoring using guided ultrasonic wave systems, finite element modelling (Abaqus), and machine learning applications in engineering. Currently, Dr. KC serves as the Director of VRG Dinamik Sdn Bhd, where he leads projects focused on structural integrity assessment, structural health monitoring, and dynamic finite element analysis. His role involves delivering engineering consultancy and innovative design solutions, including the implementation of structural health monitoring systems. Prior to this, he also worked as a Modal Analyst at the Institute of Noise and Vibration, UTM, where he conducted modal analysis and structural integrity assessments for various high-profile projects, including the vibration re-engineering of MRT infrastructures, structural health monitoring of segmental box girder highway structures for Prolintas and structural integrity assessments for LRT3. Aside from this, he is currently an EXCO member of the Association of Materials, Vibration & Insulation Practitioners, Malaysia (AMVIP), where he plays a crucial role in advancing vibration technologies by promoting the integration of these technologies into professional practices, enhancing industry standards, and fostering innovation in vibration measurement and analysis.

Quantifying Defects Impact in Concrete Elements During Service through Simulation-Based Analysis

ASSOC. PROF. TS. DR MOHD AZREEN MOHD ARIFFIN

Research Fellow
Forensic Engineering Centre, UTM

Associate Professor Ir. Dr. Mohd Azreen bin Mohd Ariffin is a distinguished academic specializing in concrete technology, geopolymer concrete, and forensic engineering with a key research interest in an expert on microstructural characterization, concrete and steel structures at Universiti Teknologi Malaysia (UTM). He holds a PhD in Civil Engineering from UTM. His accolades include multiple international and national awards, such as the Gold Awards at ITEX and Geopolymer Concrete Competitions. As a researcher, he has led and contributed to numerous national and international projects, securing over RM 1 million in research grants. Assoc. Prof. Ir. Dr. Mohd Azreen has authored multiple publications in high-impact journals, covering advanced materials in civil engineering and durability studies, and has presented his work globally. In academia, he has supervised multiple PhD and MSc students, developed various courses, and contributed to numerous professional committees. His contributions to forensic engineering and sustainable construction have also been recognized with multiple patents and copyrights related to innovative building materials. He has since expanded his expertise through research and collaborations on national and international projects with Hanyang University Korea as a research fellow and has been a guest speaker at numerous national and international conferences.

Synopsis

Concrete elements are widely used in construction due to their strength, durability, and to some extent fire resistance, but they are susceptible to various defects over time. These defects, whether caused by environmental exposure, mechanical wear and tear, or construction imperfections, can significantly affect the performance and safety of concrete structures. Today's presentation title will be Quantifying Defects Impact in Concrete Elements During Service through Simulation-Based Analysis. The content of the presentation will be in the following order: General introduction on concrete, types of Portland cement, functions of admixture, pozzolans, cement-free concrete (geopolymer), properties of concrete, concrete mix design, concrete deterioration, types of concrete failures, types of cracks, destructive and non-destructive test, condition survey of building in service system, Exploratory Data Analysis (EDA) and simulation-based analysis. This study uses simulation-based analysis to quantify the effects of defects in concrete elements during their service life. Advanced computational models are developed to simulate the progression of common defects such as major and minor cracks, spalling, and voids under varying loads and environmental conditions. The analysis incorporates material properties, defect types and conditions, and their geometrical characteristics to predict future structural performance and serviceability reduction. The results highlight the critical thresholds where defect propagation accelerates, leading to failure, and provide insights into maintenance scheduling and structural integrity monitoring. This approach helps engineers and researchers better understand defect behaviors, ensuring safer and longer-lasting concrete structures by facilitating data-driven maintenance decisions.

Materials for Marine Structures

Synopsis

This project was a reinstatement of a finger pier, which is a part of the repair of a jetty. The finger pier structure was built in the 1974. Since the structure was exposed to severe tidal splash conditions throughout its service life, the structure and the steel piles suffered severe corrosion and deterioration. Detailed inspection was conducted and confirmed that the structural capacity of the finger pier was compromised and was inadequate for the full capacity operation of the finger pier. Therefore, it was decided that additional piles and structures should be added to restore the full capacity of the finger pier. The existing structure was not demolished but rather it served as the working platform for the construction. Sequences of work including hacking, piling, installation and fabrication of pile collars, formwork installation, and concrete castings were carefully planned to ensure sufficient working space, safety, mobilisation of machinery, and cost optimisation of the project. Stringent quality control to ensure that the materials, reinforcements and dimensions are good for the construction. After the construction, the finger pier was restored to its full operation capacity and has its working life extended.

IR. MA LAM FATT

Senior Manager
Malaysia Marine & Heavy Engineering (MMHE)

Ir. Ma Lam Fatt is a Professional Engineer, registered with the Board of Engineers Malaysia since 2006, with over 25 years of extensive experience in design consultancy, project management, and construction management. Currently serving as a Senior Manager at Malaysia Marine & Heavy Engineering (MMHE), he leads the facilities and asset management division. Previously, he held roles such as Yard Development Manager at Sapura Kencana Berhad and Design Engineer & Resident Engineer at Sinclair Knight Merz Sdn Bhd.

Ir. Ma's academic credentials are remarkable. He earned his first Bachelor's degree in Civil & Structural Engineering from the University of Manchester Institute of Science and Technology (UMIST) in 1998, followed by a Master's degree in Civil Engineering from the National University of Singapore (NUS) in 2000. While working as a Consulting Civil Engineer at Sinclair Knight Merz, he expanded his expertise to finance, passing 14 papers of the Association of Certified Chartered Accountants (ACCA) in 2002 and completing all three levels of the Chartered Financial Analyst (CFA) program by 2006. In 2014, Ir. Ma furthered his technical knowledge with a second Master's degree in Offshore Technology from NUS. He also obtained a second Bachelor's degree in Law from the University of London in 2021 and a Post-Graduate Diploma from the University of Reading in 2022. He is currently pursuing a Diploma in Estate Agency, expected to be completed in 2025.

Ir. Ma's diverse expertise in engineering, leadership, and law equips him to drive high-impact results in complex engineering projects, particularly in the marine structures sector, including dry docks, quays, wharfs, bulkheads, skid tracks, and jacking foundations for marine and heavy engineering applications.

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Acknowledgement

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