Abstract Proceedings

International Conference on Geo-Disaster and Construction Engineering (ICGCE 2024)

June 07-08, 2024

At Conrad Gebrel University College, University of Waterloo, Ontario, Canada

Organized by:

KMC Canada Inc.

Co-organized and Supported by:

Geomaple Geotechnics Inc.

汕頭大學 SHANTOU UNIVERSITY

Global Institute for Interdisciplinary Studies

Abstract Proceedings

International Conference
on
Geo-Disasters and Construction Engineering

(ICGCE 2024)

June 07-08, 2024

At Conrad Gebrel University College, University of Waterloo, Ontario, Canada

Organized by:

KMC Canada Inc., Canada

Editors:
Dr. Suman MANANDHAR
Prof. Fauziah AHMAD
Dr. Babloo CHAUDHARY
Dr. Arvind Kumar JHA

Co-organized by:

Geomaple Geotechnics Inc., Canada

Shantou University, China

Indian Institute of Technology Patna, India

Global Institute for Interdisciplinary Studies (GIIS), Nepal

Kasetsart University, Thailand

Suranaree University of Technology, Thailand

King Mongkut's Institute of Technology Ladkrabang, Thailand

National Institute of Technology Karnataka, Surathkal, India

Sponsored by:

Shantou University
(Diamond Sponsor)

Geomaple Geotechnics Inc.
(Gold Sponsor)

Altitude Geospatial Incorporated
(Supporting Partner)

Global Institute for Interdisciplinary Studies
(Supporting Partner)

GMH Engineering
(Supporting Partner)

Maha Lachchya Services (MLS)
(Supporting Partner)

Result Build Inc.
(Supporting Partner)

Preface

We are delighted to warmly welcome all distinguished participants to the First International Conference on Geo-Disaster and Construction Engineering (ICGCE 2024), which will be held from June 07 to 08, 2024, in the charming city of Waterloo, Ontario, Canada. This conference holds great promise for bringing together experts from various fields, including academia, industry, and organizations, to address topics related to long-term sustainability and resilience. With the aim to amalgamate these areas, we have curated a range of interconnected themes spanning from geo-disasters to DRRM, Crisis Management, and Quality Control to Quality Assurance in construction management.

The conference is co-organized by Shantou University, Geomaple Geotechnics Inc., Indian Institute of Technology Patna, Global Institute for Interdisciplinary Studies (GIIS), Kasetsart University, Suranaree University of Technology, King Mongkut's Institute of Technology Ladkrabang, and National Institute of Technology Kartnataka, Surathkal.

Further support is extended by Conrad Gebrel University College of University of Waterloo, GMH Engineering Inc., Mahalakhsya Services Inc., Result Build Inc., VIA Rail Canada together with the support of Hampton Inn and suites, Air Canada, Crowne Plaza, WestJet and PayPal.

The main aim of the conference is to cover diverse areas of focus within Geo-Disasters and Construction Management that include the analysis and impact of natural geo-disasters on infrastructure construction and the ensuing geo-hazards. The resilience of communities in managing and mitigating disasters, especially amidst climatic shifts, is a significant subject. Additionally, the emphasis lies on crisis management strategies, particularly at construction sites, while deliberating on disaster risk reduction policies for societal well-being. Structural challenges in constructing high-rise buildings and innovative approaches like using precast delta beams highlight the evolving construction landscape. Engineering geological and geotechnical techniques play pivotal roles, featuring ground improvement methods such as permafrost ground enhancement and innovative waste-recycle material utilization. The application of geospatial analysis including advanced LIDAR techniques and multi-hazard assessments in resilient urban development, coupled with ground and slope reclamation methods, underscores the importance of holistic planning. Lastly, ensuring quality control and assurance in construction and DRRM remains a paramount consideration throughout these endeavors. The conference further aims to bring together scientists, researchers, engineers, professionals, and policymakers from across the globe, fostering a platform for vigorous debate and discussion on these critical issues to sustain the global society firmly. Our goal is to inspire active participation from all stakeholders including industries, government bodies, and academic institutions alike that will spark a significant change in the current strategies used to tackle the ongoing challenges faced by humanity in the globe.

Our call for papers has received an outstanding global response, with submissions from numerous countries across major continents. The technical committee is thrilled with the captivating and thought-provoking papers received. We are honored to feature a robust lineup for this conference, including the following lecture series.

Five Plenary Lectures: These sessions will be delivered by distinguished experts who will share their groundbreaking research and visionary insights, setting the tone for the conference.

Fourteen Keynote Lectures: Esteemed speakers from various interdisciplinary domains will present their latest findings and thought-provoking ideas, contributing to the rich diversity of topics covered.

Five Invited Lectures: These talks will focus on specific areas of interest, delivered by invited experts renowned in their respective fields.

IRCC Workshop: This workshop promises to be an engaging and informative session, providing hands-on learning experiences and interactive discussions related to work permit and high-skilled immigrants.

Additionally, 50 lectures will be delivered over the two-day conference, covering a broad spectrum of topics and ensuring that attendees gain a comprehensive understanding of the latest developments in their fields.

Given the overwhelming response, the conference will be hosted in two formats to accommodate all participants: Hybrid Mode and Fully Online Mode in the Asian Time Zone.

Hybrid Mode will combine both online and in-person attendance, allowing participants to join in the way that best suits their circumstances.

Fully Online Mode in the Asian Time Zone will be managed by one of our Secretary Generals, this format will ensure accessibility for participants in the Asian region. The online conference will feature five plenary lectures, 13 keynote lectures, and 23 general presentations, all broadcast live.

In total, 59 abstracts will be showcased in the proceedings volume of this conference, providing a comprehensive overview of the research presented.

We extend our sincere gratitude to our co-organizers, supporting organizations, and generous sponsors. Their contributions have been vital to the success of this conference, ensuring that we can deliver a high-quality event. Special thanks go to the conference co-chairperson, secretary generals, organizing committee members, international advisory board members, and other committee members for their unwavering support and dedication.

This conference promises to be an exceptional platform for exchanging ideas among a diverse group of attendees, including researchers, engineers, designers, consultants, government officials, academics, and students. Our goal is to facilitate the dissemination of knowledge and foster collaborations that can drive innovation and progress.

We are also proud to announce that Springer Nature will publish a special volume of full papers in **"Smart Construction and Sustainable Cities"**, hosted by Shantou University. This publication will follow a rigorous peer review process, ensuring that the highest quality research is disseminated to the global community.

In closing, we deeply appreciate the voluntary contributions of the international advisory committee members, plenary lecturers, keynote speakers, invited speakers, general presenters, and session chairs. Their dedication and expertise are key to the success of this conference. With the enthusiastic participation of all attendees, we are confident that this conference will be a remarkable success, advancing knowledge and fostering new collaborations in the field.

Er. Kiran Hari Pradhan
Chairperson, Organizing Committee, ICGCE 2024
CEO, KMC Canada Inc.
Ontario, Canada

Dr. Suman Manandhar
Chairperson, Technical Committee, ICGCE 2024
Research Fellow
Global Institute for Interdisciplinary Studies, Nepal

Acknowledgment

Sponsorship

The Organizing Committee of the First International Conference on Geo-Disasters and Construction Engineering (ICGCE 2024) and the editors of this book would like to extend our heartfelt gratitude for the financial support provided by the following organizations: Shantou University, China (Diamond Sponsor), Geomaple Geotechnics Inc., Canada (Gold Sponsor), Geo Altitude, Canada (Silver Sponsor), and the Global Institute for Interdisciplinary Studies (GIIS), Nepal. Your generous contributions have been invaluable to the success of this conference.

Panel of Reviewers

The manuscripts included in this book were meticulously reviewed for quality and clarity of technical content by the review panel, which comprised the following international experts.

Dr. Agneiszka Dabska, Warsaw University of Technology, Poland
Dr. Amit Kumar Verma, Indian Institute of Patna, India
Dr. Ardy Arsyad, Hasanuddin University, Indonesia
Dr. Arvind Kumar Jha, Indian Institute of Patna, India
Dr. Babloo Chaudhary, National Institute of Technology, India
Prof. Catherine Mulligan, Concordia University, Canada
Professor Emeritus, Dennes T. Bergado, Asian Institute of Technology, Thailand
Prof. Dipanjan Basu, University of Waterloo, Canada
Prof. Fauziah Ahmad, Universiti Sains Malaysia, Penang, Malaysia
Dr. Jiratchaya Ayawanna, Suranaree University of Technology, Thailand
Professor Emeritus, Keioko Kitagawa, Saga University, Japan
Prof. Koichiro Ohgushi, Saga University, Japan
Professor Emeritus, M. R. Madhav, JNT University, India
Dr. Mahmoud Fawzy Awad-Allah, National Research Center, Egypt
Prof. Marolo Alfaro, University of Manitoba, Canada
Dr. Michael Whitworth, AECOM UK, UK
Prof. Panich Voottipruex, King Mongkut's University of Technology North Bangkok, Thailand
Prof. Pitthaya Jamsaang, King Mongkut's University of Technology North Bangkok, Thailand
Dr. Pritam Shrestha, Humber College, Canada
Prof. Rolando Orense, University of Auckland, New Zealand
Dr. Salisa Chaiyaput, King Mongkut's Institute of Technology Ladkrabang, Thailand
Dr. Shahab Yasrebi, Geomaple Geotechnics Inc., Canada
Dr. Sujata Shrestha, Global Institute of Interdisciplinary Studies, Nepal
Prof. Suksun Horpibuksuk, Suranaree University of Technology, Thailand
Dr. Suman Manandhar, Global Institute for Interdisciplinary Studies, Nepal
Dr. Suthasinee Artidteang, Department of Public Works and Town & Country Planning, Thailand
Prof. Suttisak Soralump, Kasetsart University, Thailand
Prof. Takenori Hino, Saga University, Japan
Professor Emeritus, Tatsyua Koumoto, Saga University, Japan
Prof. Tri Harianto, Hasanuddin University, Indonesia
Prof. Trilok Nath Singh, Indian Institute of Technology Patna, India
Dr. Uttam Babu Shrestha, Global Institute of Interdisciplinary Studies, Nepal
Dr. Vivi Anggraini, Monash University Malaysia, Malaysia
Dr. Zentaro Furukawa, Okayama University, Japan

Organizational Structure

Chairpersons

Er. Kiran Hari Pradhan, Organizing Committee, KMC Canada Inc., Canada
Dr. Suman Manandhar, Technical Committee, Global Institute for Interdisciplinary Studies, Nepal

Co-chairperson
Dr. Pritam Shrestha, Humber College, Canada

Secretary Generals.
Dr. Babloo Chaudhary, National Institute of Technology Karnataka Surathkal, India
Prof. Fauziah Ahmad, Universiti Sains Malaysia, Penang, Malaysia
Er. Manjul Acharya, KMC Canada Inc., Canada

Members
Dr. Amit Kumar Verma, Indian Institute of Patna, India
Dr. Arvind Kumar Jha, Indian Institute of Patna, India
Prof. Catherine Mulligan, Concordia University, Canada
Prof. Dipanjan Basu, University of Waterloo, Canada
Prof. Marolo Alfaro, University of Manitoba, Canada
Mr. Mathew Francis, AECOM, USA
Mr. Mukesh Pandey, KMC Canada Inc., Canada
Dr. Salisa Chaiyaput, King Mongkut's Institute of Technology Ladkrabang, Thailand
Prof. Shui-Long Shen, Dean, College of Engineering, Shantou University, China
Prof. Suksun Horpibuksuk, Suranaree University of Technology, Thailand
Prof. Suttisak Soralump, Kasetsart University, Thailand
Prof. Trilok Nath Singh, Indian Institute of Patna, India
Dr. Uttam Babu Shrestha, Global Institute of Interdisciplinary Studies, Nepal

International Advisory Committee

Chairperson
Dr. Suman Manandhar, Technical Committee, Global Institute for Interdisciplinary Studies, Nepal

Co-chairperson
Prof. Fauziah Ahmad, Universiti Sains Malaysia, Penang, Malaysia

Members
Dr. Agneiszka Dabska, Warsaw University of Technology, Poland
Dr. Ardy Arsyad, Hasanuddin University, Indonesia
Dr. Arvind Kumar Jha, Indian Institute of Patna, India
Prof. Askar Zhussupbekov, Eurasian National University, Kazakhastan
Professor Emeritus, Dennes T. Bergado, Asian Institute of Technology, Thailand
Mr. Habendra Prasad Dev, Rajdevi Engineering Consultant Pvt. Ltd., Nepal
Dr. Hing-Ho Tsang, Swinburne University of Technology, Austtralia
Prof. Jae Eun Lee, Chungbuk National University, South Korea
Dr. Jiratchaya Ayawanna, Suranaree University of Technology, Thailand
Professor Emeritus, Keioko Kitagawa, Saga University, Japan
Prof., Koichiro Ohgushi, Saga University, Japan
Professor Emeritus, M. R. Madhav, JNT University, India
Dr. Mahmoud Fawzy Awad-Allah, National Research Center, Egypt
Mr. Mathew Francis, AECOM USA, USA
Dr. Michael Whitworth, AECOM UK, UK
Prof. Noriyuki Yasufuku, Kyushu University, Japan
Prof. Panich Voottipruex, King Mongkut's University of Technology North Bangkok, Thailand
Prof. Pitthaya Jamsaang, King Mongkut's University of Technology North Bangkok, Thailand
Prof. Rolando Orense, University of Auckland, New Zealand
Dr. Salisa Chaiyaput, King Mongkut's Institute of Technology Ladkrabang, Thailand
Prof. San-Shyan Lin, National Taiwan Ocean University, Taiwan
Prof. Shui-Long Shen, Dean, College of Engineering, Shantou University, China
Dr. Sujata Shrestha, Global Institute of Interdisciplinary Studies, Nepal

Prof. Suksun Horpibuksuk, Suranaree University of Technology, Thailand
Dr. Suthasinee Artidteang, Department of Public Works and Town & Country Planning, Thailand
Prof. Suttisak Soralump, Kasetsart University, Thailand
Prof. Takenori Hino, Saga University, Japan
Professor Emeritus, Tatsyua Koumoto, Saga University, Japan
Prof. Tri Harianto, Hasanuddin University, Indonesia
Dr. Vivi Anggraini, Monash University Malaysia, Malaysia
Dr. Zentaro Furukawa, Okayama University, Japan

Table of Contents

Plenary Lectures

Transformative Impact of Artificial Intelligence on Geotechnical Engineering and Soil Improvement Techniques

Shahab Yasrebi

ABSTRACT

The continuous evolution of soil improvement techniques is critical for the successful execution of infrastructure projects. In this presentation, we explore how Artificial Intelligence (AI), innovative methods, and sustainable practices are shaping the future of geotechnical engineering.

Key Points:

1. **Importance of Soil Improvement:**
   - Soil improvement plays a vital role in enhancing the stability, durability, and safety of infrastructure.
   - Addressing challenges such as soil stability, load-bearing capacity, and settlement control, effective soil improvement minimizes risks and maintenance costs, ensuring long-term performance.

2. **Historical Development and Impact:**
   - Tracing the historical development of soil improvement techniques, from ancient practices to modern methods, reveals their significant impact on infrastructure projects.
   - Technological progress and material innovation have continuously advanced these techniques, addressing complex geotechnical issues.

3. **Infrastructure's Role and Soil Improvement Practices:**
   - Infrastructure is the backbone of societal development, facilitating economic growth, social connectivity, and quality of life.
   - This presentation emphasizes the indispensable functions of infrastructure, particularly its influence on transportation, communication, public health, and urban development.
   - Robust soil improvement practices are essential for infrastructure stability.

4. **Geotechnical Engineering and Challenges:**
   - Geotechnical engineering is fundamental to the planning, design, and construction of infrastructure.
   - Key concepts and challenges in this field include soil behavior, site investigation, and foundation design.
   - Geotechnical engineers play a critical role in ensuring stability and safety.

5. **AI Revolution in Soil Improvement:**
   - Traditional soil improvement methods have inherent limitations.
   - AI can address these limitations by enhancing soil analysis, predicting soil behavior, and optimizing improvement methods.
   - The integration of AI into geotechnical engineering offers enhanced accuracy, efficiency, and predictive capabilities.

[1] President, Geomaple Geotechnics Inc, CANADA, s.yasrebi@geomaple.ca

6. **Real-World Case Studies:**
    - Real-world case studies illustrate how AI has solved specific geotechnical problems, improved project outcomes, and achieved cost savings.
    - These examples highlight the tangible benefits and lessons learned from integrating AI into soil improvement practices.
7. **Future Scope and Challenges:**
    - The future scope of AI in geotechnical engineering includes potential advancements in automated site investigations, predictive modeling, and smart infrastructure.
    - Emerging trends and future directions for AI in determining soil properties and designing improvement solutions will be discussed.
8. **Innovation and Recommendations:**
    - Innovation is essential for advancing soil improvement methods and addressing contemporary geotechnical challenges.
    - Implementing AI in soil improvement presents challenges related to data quality, algorithm reliability, and integration with existing practices.
    - Specific, actionable recommendations for professionals seeking to implement AI in their soil improvement projects will be provided.

Investigations of Pile Foundations of 70 m High New Monument in Astana City

Askar Zhussupbekov [1] and Abdulla Omarov [2]

ABS T RA CT

The fact that norms and standards do not always apply to unique structures makes construction of such structures difficult. An account of the investigation, design, wind tunnel testing, and field monitoring of a 70-meter-tall monument that was built in the Republic of Kazakhstan's capital city of Astana is provided in this paper. This summary serves as a helpful illustration of the limitations imposed by such singular, one-of-a-kind systems. Scale models were built in order to examine the monument's reaction. A scaled model of the building's surfaces had its pressure distribution measured at various wind angles and speeds. These investigation statements on load experiments conducted in Astana, Kazakhstan, on deep drilled piles with a diameter of 820 mm. In the Astana New Monument building site, drilled piles of over 820 mm in diameter and 13.5 m in depth were placed. Static and dynamic loading techniques are typically used in Kazakhstan for pile load testing. Static testing of piles is the most dependable technique for figuring out the load-settlement ratio of piles **Fig. 1**.

At 4.9 to 5.1 meters below the surface, the groundwater table was found during soil explorations conducted at the monument site. The mechanical and physical characteristics of the soils found at the monument site are listed in **Table 1**.

A total of 2280.9 tons was the design load from the structure operating on the foundation. The deep foundation was required because to the difficult nature of the soils at the monument site. Historically, driven piles have made up the majority of deep foundations. However, the strength of the material used to construct the pile and its cross-sectional dimensions place some restrictions on how far these piles may be driven.

Soil examinations at the monument site revealed the groundwater table to be 4.9 to 5.1 meters below the surface. **Table 1** enumerates the mechanical and physical properties of the soils present at the monument site.

The design load from the structure working on the foundation was 2280.9 tons in total. The challenging soil conditions at the monument location necessitated the deep foundation.

Field static load testing (SLTs) are one of the most dependable methods for measuring the load-settlement response of piles and figuring out their bearing capacity at a particular site (**Fig. 2**). The current standards for these tests in the CIS are SNIP RK 5.01.03-2002 and GOST 5686-94. The outcomes of these tests enable a deep foundation's design to be altered if needed.

Static, stepwise compressive indentation loading with load increments equal to 105.5 kN was applied to three of the bored piles. Each of these piles could support a maximum weight of 1,477 kN. In these three experiments, the maximum settlements measured were 4.62, 5.33, and 5.59 mm. The load-settlement curves for the SLTs carried out at the monument site are shown in **Fig. 3**.

Table 1. Soil characteristics at the monument.

EGE	Soils	Design data soil soaking in natural state				
		E, Mpa	ρ, g/cm^3	c, kPa	fo	Ro, kPa
1	Loams	12.5	1.91	38	19	-
2	Sands	17.0	1.92	2.0	35	-
3	Coarse sands	21.0	1.92	1.0	38	-
4	Gravel soils	23.0	-	-	-	300
5	Loams	14.0	2.04	27	27	-

[1] Professor, Eurasian National University, Astana, KAZAKHSTAN, astana-geostroi@mail.ru
[2] Associate Professor, Eurasian National University, Astana, KAZAKHSTAN, omarov_01@bk.ru

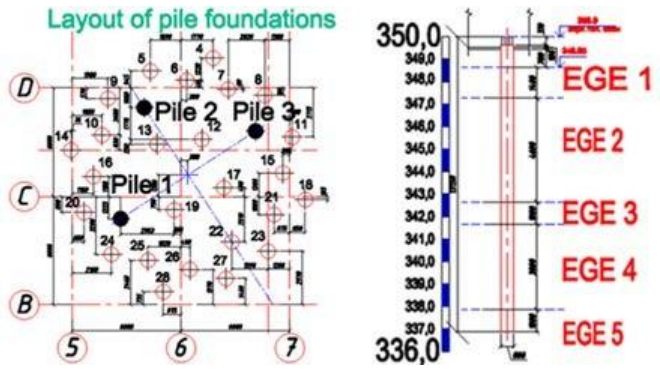


Fig. 1. Location of static pile load tests and bored piles at the monument construction site.

Fig. 2. Static load test on construction site.

Static, stepwise compressive indentation loading with load increments equal to 105.5 kN was applied to three of the bored piles. Each of these piles could support a maximum weight of 1,477 kN. In these three experiments, the maximum settlements measured were 4.62, 5.33, and 5.59 mm. The load-settlement curves for the SLTs carried out at the monument site are shown on **Fig. 3**.

SLTs were carried out in the case of the bored piles at the monument site when the concrete had solidified at 80% of its full strength. In compliance with Kazakhstan Standard SNIP RK 5.01-03-2002 and SNIP RK 5.01-01-2002, the tested pile's final value of settling falls between 16 and 24 mm, contingent on the building type.

The SLTs were carried out at the monument site 21 days following the installation of the 13.5 m long and 820 mm diameter drilled pile (**Fig. 4**).

The SLTs were carried out in accordance with the requirements of GOST 5686-12. **Figure 3** shows the layout of the piles and the locations of the SLTs at the monument site. The latter are denoted by “Pile 1”, “Pile 2”, and “Pile 3” in the figure. Fig. 2 shows the set-up of the SLT and the platform pile layout. The foundation of the structure is laid out in the form of a grillage in which there is a technical room for the storage and maintenance of equipment. The thickness of the floor slab of the technical room is 40 cm.

Static, gradually rising tensile stresses were applied to Pile 1 (the first three load increments were equal to 105.5 kN, and the subsequent increments were equal to 52.75 kN). The testing setup and findings for this pile, which was assigned the number 3*, are displayed in **Fig. 4**. This pile could support a maximum weight of 686 kN. 2.98 mm was the matching extensional displacement. The vertical tensile load test results are likewise summarized in **Fig. 4**.

A 70 m high monument was constructed in the capital city of Astana in the Republic of Kazakhstan on the 2017 World Expo. The problematic soil conditions at the site of the monument necessitated the use a deep foundation consisting of 820 mm diameter bored piles.

The results of three vertical static load tests showed that the maximum proof load carried by these piles was 1,477 kN. The associated maximum settlements were 4.62, 5.53 and 5.59 mm. Using a factor of safety of 1.2, the allowable bearing capacity of the piles is thus 1,231 kN.

A vertical pull-out test was also performed on one of the bored piles. The maximum load for this pile was 686 kN. The corresponding extensional displacement was 2.98 mm. Using a factor of safety of 1.2, the allowable vertical pull-out load is thus 572 kN.

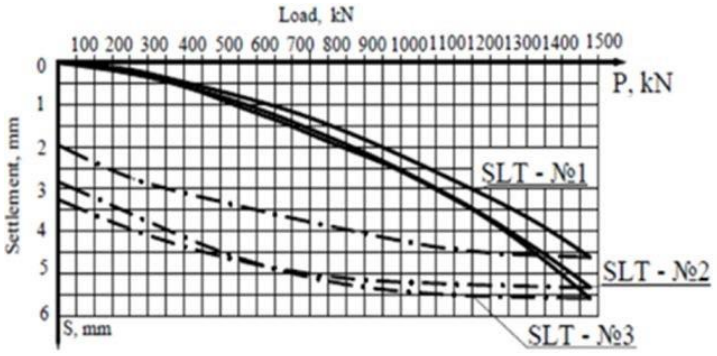


Fig. 3. Results of pile static load tests (top down).

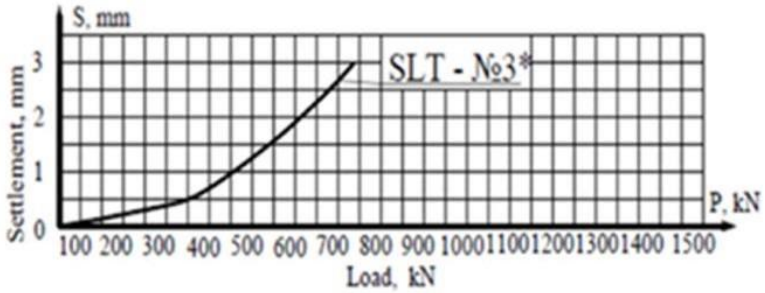


Fig. 4. Test results for vertical tensile load at the monument site Pile 3* and related outcomes.

References

American Society of Civil Engineers, 1998: Minimum design loads for buildings and other structures. ANSI/ASCE **7-95**, ASCE, New York.

Air Recommendations for Loads on Buildings: Chapter 6. Wind Loads. Architectural Institute of Japan.

Bandi, E.K., Tamura, Y., Yoshida, A., Kim, Y.C. and Yang, Q.S., 2014: Experimental investigation on aerodynamic characteristics of various triangular-section high-rise buildings. J. Wind Eng. Ind. Aerodyn., **2013**: 60-68.

Eurocode 1, 2005: Actions on structures - General actions - Part 1-4: Wind actions, CEN. p146

González-Roubaud, E., Pérez-Osorio, D. and Prieto, C., 2017: Review of commercial thermal energy storage in concentrated solar power plants: Steam vs. molten salts. Renew. Sustain. Energy Rev., **80**: 133-148.

Kim, Y.C., Tamura, Y., Tanaka, H., Ohtake, K., Bandi, E.K. and Yoshida, A., 2014: Wind-induced responses of super-tall buildings with various atypical building shapes. J. Wind Eng. Ind. Aerodyn., **133**: 191-199.

MDS 20-1.2006, 2006: Temporary recommendations for the assignment of loads and effects affecting multifunctional high-rise buildings.

Omarov, A.R., Kuderin, M., Zhussupbekov, A., Kaliakin, V.N. and Iskakov, S., 2021: Vibration measurements at a new monument in Nursultan City. International Journal of GEOMATE, **21***(85)*: 24-31.

Omarov, A.R., Zhussupbekov, A.Z., Tulegulov, A.D., Zhukenova, G.A. and Tanyrbergenova, G.K., 2016: The analysis of the piling tests on construction site “The future of the free country”. Proc. of the 8th Asian Young Geotechnical Engineers Conference, Astana:127-130.

Quan, Y. and Gu, M., 2005: Experimental evaluation of aerodynamic damping of square super high-rise buildings. Wind Struct., Int. J., **8***(5)*:309-324.

SNIP 2.01.07.-85, 1985: Loads and Impacts.

SP 20.13330.2011, 2011: Loads and Impacts. (Russian Language)

Standard Australia, 1989: Minimum design loads on structures. Part 2: Wind Loads. Standards Australia. North Sydney.

Tanaka, H., Tamura, T., Ohtake, K., Nakai, M. and Kim, Y.C., 2012: Experimental investigation of aerodynamic forces and wind pressures acting on tall buildings with various unconventional configurations. J. Wind Eng. Ind. Aerodyn: 179-191.

Tahri, M., Hakdaoui, M. and Maanan, M., 2015: The evaluation of solar farm locations applying geographic information system and multi-criteria decision-making methods: Case study in southern Morocco", Renewable and Sustainable Energy Reviews,**51**:1354-1362.

Zhussupbekov A., Sultanov G. and Omarov A., 2017: The Complexity of piling tests in problematical soil ground of Kazakhstan. Design and Analysis of Piled Raft Foundations -2017, Published in Taiwan by Tamkang University Press: 169-176.

Zhussupbekov, A., Iwasaki, Y., Omarov, A., Tanyrbergenova, G. and Akhazhanov, S., 2019: Complex of static loading tests of bored piles. International Journal of GEOMATE, **16***(58)*: 8-13.

Road to the Top of the World: Observed and Forecasted Thermal Regime under Climate Change Scenarios

Marolo Alfaro

ABSTRACT

With climate change being an important consideration for transportation infrastructure design, construction, maintenance operations in Arctic Regions, an embankment section along the Inuvik-Tuktoyaktuk Highway (ITH) in the Northwest Territories, Canada was instrumented with temperature sensors during its construction. The embankment is founded on continuous permafrost and was built using compacted frozen fill. A numerical model was developed using commercially available finite element software to simulate the thermal behavior of this embankment. The model was calibrated using the eight-year temperature data available in the embankment fill and underlying foundation. It was followed by thermal performance forecasting for near-term (i.e., less than 30 years) and long-term (i.e., to 2100) climate scenarios using Coupled Model Intercomparison Project Phase 6 (CMIP6) projections for Canada. Evaluation of the temperature data collected and the forecasted temperatures for this embankment section along the ITH will be presented. The results of the near-term and long-term climate models will provide an insight into when remediation can be employed to impede permafrost degradation and maintain embankment thermal stability.

Professor, P.Eng., University of Manitoba, Winnipeg, CANADA, Marolo.Alfaro@umanitoba.ca

Vacuum-PVD improvement: a Case Study of the Second Improvement of Soft Bangkok Clay for Third Runway Extension Project

Dennes T. Bergado [1], Pitthaya Jamsawang [2] and Nuttapong Kovittayanon [3]

ABSTRACT

This paper presents the case study of the second improvement of soft Bangkok clay using combined vacuum-PVD with surcharge embankment preloading. Airtight membranes, horizontal prefabricated drains, and a vacuum system with field-distributed air-water separation techniques were utilized. The modified air-water separation system (**Figs. 1** and **2**) utilized multiple air water separation in the field connected to a large vacuum pump station. By separating the air and water at multiple locations in the field using sub tanks (**Fig. 2**) with submersible water pumps, the turbulent flow can be minimized in all the water conduits, strip drains, collector pipes and mainly all the hoses running to the pumps to generate high efficiency vacuum-PVD system. To pump out water, submersible pumps with a power of 1.0 kW were used at each sub-tank assembly to provide maximum vacuum efficiency. The large vacuum pump station (**Fig. 2**) covers a 30,000 m^2 improvement area. The vacuum pumps can reach extremely high vacuum levels using an oil-lubricated rotary vane system with increased vacuum capacity. Monitoring instruments consisted of surface settlement plates, inclinometers, and pore pressure piezometers were installed in the underlying soft clay layer. The subsequent analyses included settlement and consolidation degree predictions using one-dimensional consolidation, the Asaoka observational method, and pore water pressure data. Back-calculation of flow parameters, comparison of soil properties before and after the first improvement were performed. The ground cracks and lateral movements induced by vacuum consolidation were also reported. After the first improvement, the very soft clay was improved into soft to medium stiff clay because its undrained shear strengths and maximum past pressures were increased. In contrast, its water contents, void ratios, and compression indexes were decreased. The results illustrated the effectiveness of the vacuum-PVD improvement with an innovative field-distributed air-water air - water separation system for the second improvement of soft Bangkok clay.

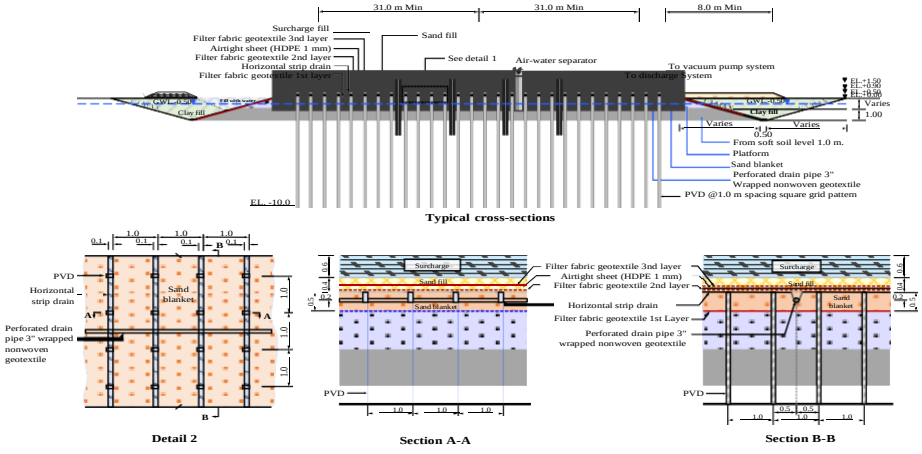


Fig. 1. T Details of the Vacuum-PVD System.

[1] Emeritus Professor and Project Consultant, Asian Institute of Technology, Bangkok, THAILAND; bergado@ait.asia
[2] Professor, Soil Engineering Research Center Director, Department of Civil Engineering, King Mongkut's University of Technology North Bangkok, Bangkok, THAILAND, pitthaya.j@eng.kmutnb.ac.th
[3] Project Director, Ceteau (Thailand) Co. Ltd., Bangkok, THAILAND, ntp@ceteau.co.th

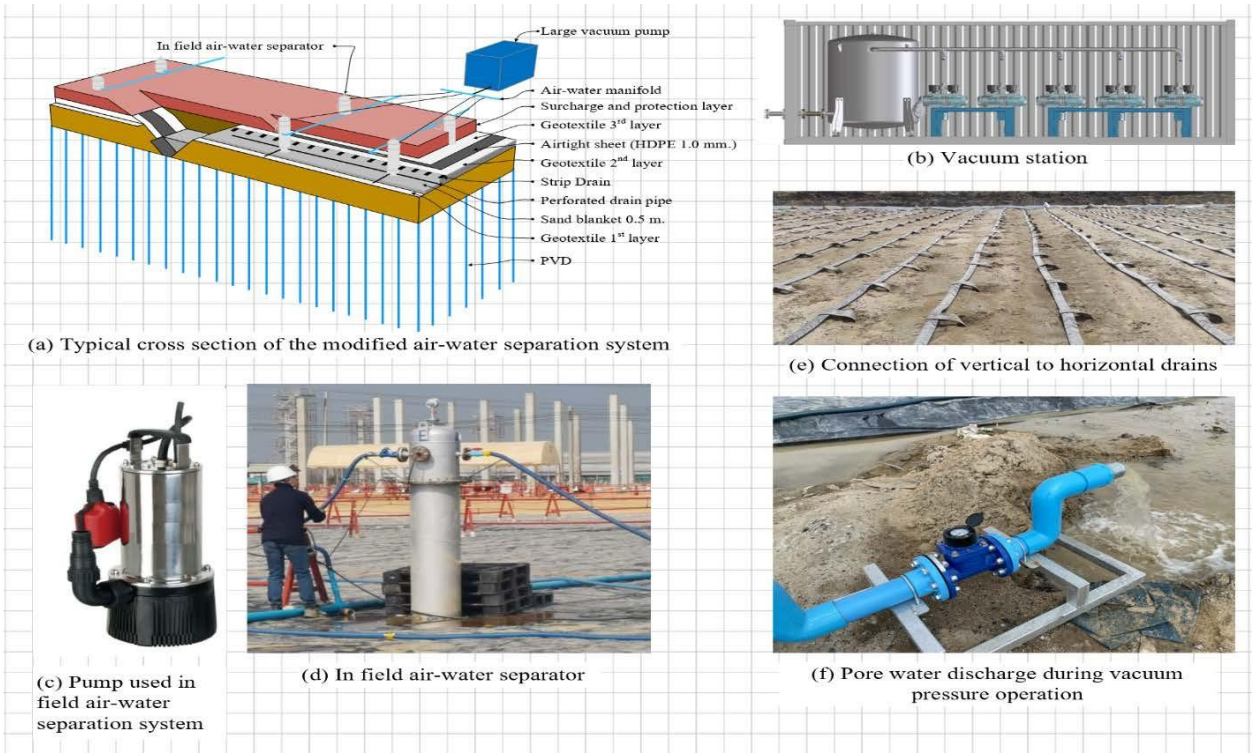


Fig. 2. The Modified Air-Water Separation System.

Sustainability and its Assessment in Geotechnical Engineering

Dipanjan Basu

ABS T RA CT

In this age of Anthropocene where human activities dominate the built and natural environments, geotechnical engineers have a strong role to play in mitigating the anthropogenic impacts on the environment because geotechnical engineering practice consumes close to 40% of the global energy consumption, depletes large amounts of sand, gravel, and stone reserves every year and adds to the problems of climate change and pollution. Sustainable practices in geotechnical engineering should take a 4-**E**'s approach in which sound **E**ngineering practices uphold the principles of triple bottom line, namely, **E**nvironment, **E**conomy, and **E**quity. Sound geotechnical engineering entails proper soil (material) characterization, thorough analysis and design, and careful monitoring. In addition, sustainability assessment and considerations for resilience must be considered in the contemporary practice of geotechnical engineering. In the first part of the presentation, a research philosophy is portrayed that upholds the 4-E's approach in geotechnical engineering. Concepts from sustainability and resilience are presented and their connection with geotechnical engineering is established. In the second part of the presentation, a study on life cycle assessment of drilled shafts is presented. It is shown that the global warming impact and human toxicity of a typical drilled shaft is 39% and 486% of annual world impact per person, respectively. Based on the study, charts and tables are developed that may be used for quick estimation of global warming impact of drilled shafts without the use of specialized LCA software programs. It is expected that the presentation will encourage geotechnical engineers to consider sustainability seriously and meaningfully in their practices.

Professor, Ph.D., P.Eng., F. ASCE, Department of Civil and Environmental Engineering University of Waterloo, Ontario, CANADA, dipanjan.basu@uwaterloo.ca

Keynote Lectures

On Innovative Thinking Way in Engineering Science and Its Applications

Shui-Long Shen

ABSTRACT

This research summarized six innovative thinking modes in the research of engineering problem: 1) transplantation innovation, 2) combination innovation, 3) refinement innovation, 4) extension innovation, 5) local change innovation, and 6) original innovation (see **Fig. 1**). Gradually increasing innovation level from 1 to 6; 1-5 is generally a 1-N innovation, while 6 is a 0-1 innovation; However, it is not absolute. If 1-N changes greatly, it can also be an innovation of 0-1. For example, Terzaghi's consolidation theory starts with the assumption of effective stress, and then the combination of seepage mechanics and solid mechanics achieves the original innovation, which solves the problem of stress and deformation of soft soil that has not been solved by predecessors. Then, we summarize the innovative research work in geotechnical engineering, especially in the intelligent construction of tunnelling in recent years: from the application of artificial intelligence algorithm to analyse geotechnical engineering data to the innovative research thinking method of modifying neural network activation function to improve calculation efficiency, and artificial intelligence to identify stratum characteristics and parameters.

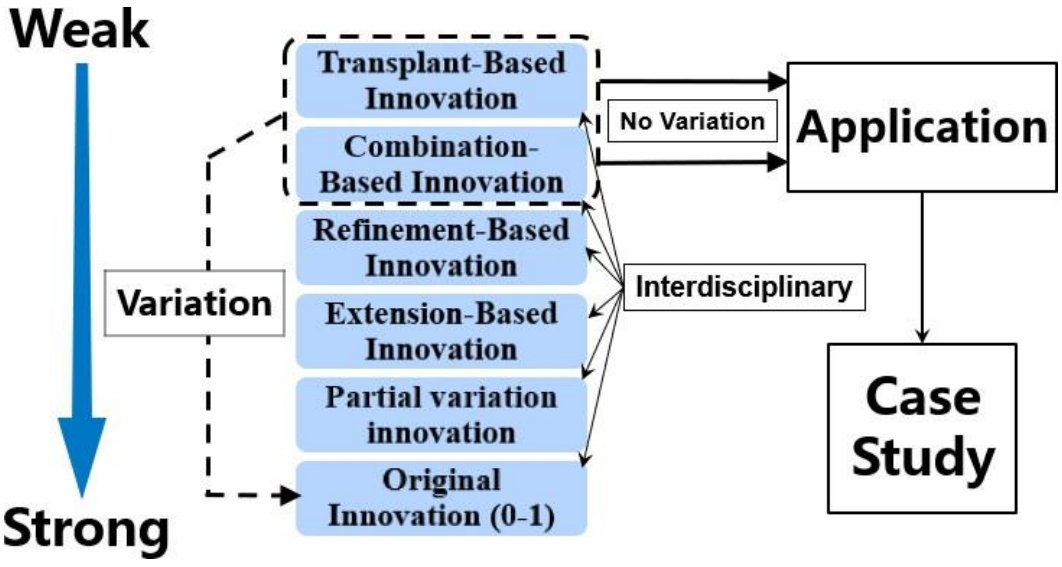


Fig. 1. Six approaches to innovative thinking way in engineering science.

Department of Civil and Smart Cities, College of Engineering, Shantou University, CHINA, shensl@stu.edu.cn

A Core System Model for Effective Crisis & Emergency Management in Crisisonomy: Analyzing the Sewol Ferry Disaster in Korea

Jae Eun Lee

ABSTRACT

This study aims to identify and propose a core system model for achieving effective and efficient crisis & emergency management system. Crisis & emergency management fundamentally involves recognizing and respecting human dignity, with a focus on addressing threats to life, safety, and health. This paper asserts that the core system of crisis & emergency management must be built upon five key elements in the field of Crisisonomy (crisis & emergency management science): value, institution, leadership, devotion, and expertise.

The study examines the Sewol ferry disaster of April 16, 2014, which tragically highlighted significant deficiencies in the Korean government's disaster management system. The Sewol ferry, carrying 476 people, mostly high school students, capsized en route from Incheon to Jeju, resulting in 304 deaths. The disaster response was heavily criticized for its disorganization and inefficiency. Rescue operations were chaotic, and the lack of a centralized control system, or 'control tower,' was a significant factor in the failure to effectively manage the crisis and emergency situation.

The core system model proposed in this study is designed to address these deficiencies. First, the model emphasizes the importance of value in guiding system operations. Values such as respect for life, human dignity, human rights, and social equity must be deeply ingrained in the crisis & emergency management philosophy. The fundamental problems of crisis & emergency management, as seen in the Sewol disaster, often stem from a lack of these guiding values and philosophies.

Second, the model calls for the establishment of robust institutions that are socially and legally accepted. These institutions provide the legitimacy needed for the core system to perform its functions. The ad hoc nature of the disaster response institutions during the Sewol incident revealed the inadequacy of temporary measures and the need for well-established, permanent institutions.

Third, leadership is highlighted as a crucial element of the core system. Effective leadership is essential for directing the system towards the achievement of common goals. The failure of government leaders to establish a new framework for dealing with catastrophic disasters was evident during the Sewol tragedy. Strong leadership is necessary to manage the complexities of disaster response and ensure coordinated efforts.

Fourth, devotion to the system's mission is identified as a key component. The dedication of system members to their roles is vital for the successful operation of the core system. The lack of training and commitment among disaster response actors during the Sewol incident underscored the need for a devoted and well-prepared workforce.

Finally, expertise is a fundamental element of the core system. Specialized knowledge and skills are essential for performing the tasks required in crisis & emergency management. The absence of expertise within the responsible government organizations during the Sewol disaster highlighted a significant gap that needs to be addressed. The system must continuously integrate new experts and provide ongoing education and training to its members.

In conclusion, the Sewol ferry disaster exposed critical weaknesses in the existing crisis & emergency management system, particularly the absence of a core system to effectively coordinate and lead response efforts. This study proposes a comprehensive core system model based on value, institution, leadership, devotion, and expertise to enhance the effectiveness and efficiency of crisis & emergency management. By implementing this model, it is possible to build a resilient and responsive system capable of handling future crises more effectively.

References

[1] Professor, Chungbuk National University, Cheongju, KOREA, jeunlee@chungbuk.ac.kr

Bertalanffy, L.von: 1950: An Outline of General System Theory. The British Journal for the Philosophy of Science. **1**(*2*): 134-165.

Bertalanffy, L. von: 1968. General Systems Theory: Essays on Its Foundation and Development. New York: George Braziller.

Boulding, K.E: 1956. General Systems Theory: The Skeleton of Science. Management Science. **2**(*3*): 197-208.

Easton, D., 1957: An Approach to the Analysis of Political System. World Politics. 9(April 1957): 383-400.

Laszlo, A. and Stanley, K., 1998: Systems Theories: Their Origins, Foundations, and Development. J. S. Jordan. ed. Systems Theories and A Priori Aspects of Perception. Amsterdam: Elsevier Science.

Lee, J.E., 2012: Crisisonomy. 2nd ed. Seoul: Daeyoungmunhwa-sa.

Lee, J.E., 2014. Core System and Disaster Management : Failure of the Sewol Ferry Disaster Response System. Journal of Safety and Crisis Management. **4**(*2*): 20-26.

Lindell, M.K., Carla, P. and Ronald, W.P., 2007: Introduction to Emergency Management. MA: John Wiley & Sons.

Luhmann, N., 1975: Systemtheories, Evolutiontheorie und Kommunikationstheorie. Soziologische Gids. **22**(*3*): 154-168.

Luhmann, N., 1982: The World Society as a Social System. International Journal of General Systems, **8**(*3*): 131-138.

Nam, B.L., 2010: Luhmann's System Theory and the Rationality of Sirhak. Korean Journal of Social Science, **31**(*2*): 1-14.

Overman, E.S., 1998: Systems Theory. Jay M. Shafritz (editor in chief). International Encyclopedia of Public Policy and Administration. **4**. Boulder, CO: Westview Press.

Parsons, T., 1950: The Social System. Glencoe. Parsons, Talcott. 1975. Social Systems and The Evolution of Action Theory. New York: The Free Press.

Yong, J.K., 2012: The Korean Politics and System Theoretical Analysis: Theories and Applications. Korean Journal of Political and Diplomatic History. **34**(*1*): 113-146.

Development of Flood Protection Infrastructures in Bangkok Lowland and Ground Subsidence Area

Suttisak Soralump

ABSTRACT

Located in the marine deltaic environment, a young, deposited sediment and the elevation which close to mean sea level, Bangkok's major disaster risk is flooding. The delta area was created by 4 major rivers pouring tons of sediment, mostly clay particles since the starting of Holocene period. The approximation of 100x100 km2 area is once inundated by the seawater. The sea water level started to recede about 6,000 years ago. With combination of the deposited of sediment as mentioned, the dry land started to emerge. Therefore, the topmost layer of Bangkok's subsoil is a young marine clay called Bangkok soft clay which is underlain by the stratification of aquifer layers as deep as a kilometer. This makes a large natural underground water resource conveniently available for the city.

Bangkok city was founded as the capital city in 1782. The city is enriched with fertile soil and canals to accommodate the agricultural, transportation, seasoning flood passages and floating house living style. People in those days relied their living on water in canal and rain and adapted themselves to live with flood water, Thai tradition house is then designed to be elevated floor (Fig xx) to be able to be flooded in water season. They seemed to have no trouble with seasoning floods in this newly deposited and lowland area. It was until 1863 when the first street in Bangkok was built and the living style was slowly but permanently changed with the coming of automobile. People started to live in a modern style house with no elevated floor. The first housing project in Bangkok supported by the government was erected in 1955. These modern living requires backfill soil to adjust ground elevation to be above the flood water level. However, filling soil above soft clay layer caused long term settlement of fills. Besides, the thickness of the soil fills may be higher than just a regular flood but not the high return period flood. Therefore, Bangkok started to suffer with flood water. Recording big flood that started to affect the living of Bangkok people was in 1942, 1976, 1980 and 1983. Most of the flood water came from the overland water flow from the rivers that flow from the northern and central part of the country, flowing into Bangkok deltaic area before discharge into the gulf of Thailand. However, flood also generated from the accumulated rainfall that fall directly in Bangkok area. In both cases, flood water is difficult to drain since the area is flat, flood water may inundate the area for weeks or months.

The situation was becoming complicated in late 1970's when Thailand started to be moving toward the industrial economics. The agricultural land in Bangkok and vicinity cities was filled with earth and replaced by factories. Furthermore, the population in Bangkok also increased constantly, approximately 1 million people increasing in each decade. Therefore, the demand of clean water was increasingly high. Even though Metropolitan Waterworks Authority (MWA) was established since 1967 but the production of purified water was unmatched with the increasing demand as mentioned. Therefore, the use of under groundwater has been increasing substantially since then. The signs of excessive use of underground water were the rapid increase in ground subsidence throughout Bangkok, especially in the area of high use of underground water. The rate of ground subsidence was about 10 cm/year during 1978-1985. It was until 1997 when the limitation of underground water was enforced by the underground water control act, and the situation of ground subsidence was getting better. As of now there is no or little ground subsidence in Bangkok city. However, the ground that already subsided cannot recover back. Therefore, several areas in Bangkok, especially in the east side of the city have ground elevation lower than mean sea level. Some areas have subsided for about a meter. That was a fire back to the flooding situation and make the flood drainage work much more difficult.

Above is the background that are related with the current flood protection and flood management in Bangkok. After the big flood in 1983, King Rama the 9 th had advised the government to build a flood protection dike surrounding Bangkok city and along the main river. The dike is called King's dike. Since that time, Bangkok has been developing a

[1] Geotechnical Engineering Research Center (GERD), Department of Civil Engineering, Kasetsart University, THAILAND, soralump_s@yahoo.com

complete polder system consisting of dikes, flood walls, flood canals, gates, pumps, flood tunnels, underground water banks and retention ponds. With an area of 7,762 km2, Bangkok Metropolitan Region might be one of the largest completed flood control-polder systems in the world. The flood control system has to manage the peak flood volume of up to 800 million m3 per month or accumulation of 4,000 million m3 per year in order to serve about 15 million people who live in Bangkok Metropolitan Region. Even so, the 2011 great Bangkok flood broke the protection system (Fig 1). This reminds the basic of engineering in which always come with its limitations.

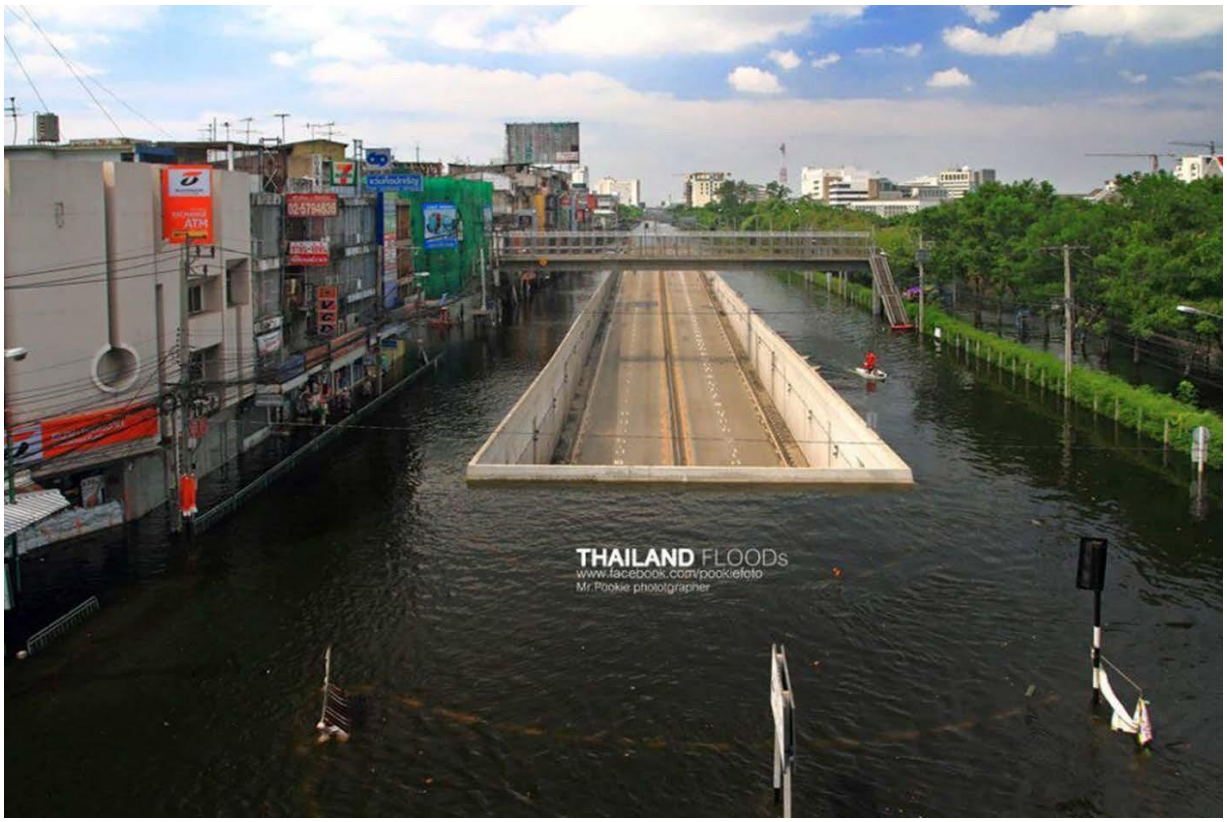


Fig. 1. Bangkok great flood in 2011.

Enhanced Tensile Fatigue Performance of Cement Stabilized Pavement Base Using Natural Rubber Latex

Suksun Horpibulsuk [1], Apinun Buritatutum [2], Menglim Hoy [3], Apichat Suddeepong [4], Artit Udomchai [5], Teerasak Yaowarat [6], and Arul Arulrajah [7]

ABS T RA CT

A pavement structure is generally composed of base and subbase layers, which play an important role in the bearing capacity and serviceability of the road. This pavement structure requires high-quality soil as a construction material. However, natural soils exhibit unfavorable physical and engineering properties, often unsuitable for high-volume road construction. Traditional additives include lime, fly ash, and cement. In general, these substances' effectiveness and reliable performance have been extensively researched, usually related to their interaction behaviors. The utilization of Portland cement as a stabilizer is preferred to other additives in Southeast Asia, due to its cost effectiveness and the rapid enhancement of mechanical properties, including the bearing capacity, stiffness, and strength of the soil.

The higher cement content of such roads however reduces tensile fatigue life especially at a large strain level; hence, the sudden failure occurs with crack initiation. In order to mitigate this shortcoming, natural rubber latex (NRL) can be used as an environmental-friendly additive in cement stabilization. Since the NRL is in liquid state, the input of NRL as a replacement ratio by total liquid content was convenient for fieldwork. Portland cement (Type I) contents (c) were varied at 3%, 5% and 7% by weight of dry soil and the NRL replacement ratios were varied at 10%, 15%, 20%, 25%, and 30% by weight of water. The effect of influence factors was studied in this research, which included: types of soil, NRL replacement ratio, and cement content on unconfined compressive strength (UCS), indirect tensile strength (ITS), indirect tensile resilient modulus (IT Mr) and indirect tensile fatigue life (ITFL). The mechanical strengths improvements were examined through scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDS) analyses.

The ITS and UCS are contributed from both cementitious products and NRL films, which improved cohesive matrix by means of reinforcements from NRL films formation. Though NRL films improves the soil cohesion, they retard the hydration. The UCS and ITS therefore increase with increasing the NRL replacement ratio up to the highest value at the optimum NRL replacement ratio, which is equal to 20%, 15%, and 10% at C = 3%, 5%, and 7%, respectively. The normalized UCS and ITS of cement-NRL stabilized soils are controlled by the same influence factor. Similar to the ITS results, the highest IT Mr and ITFL values was found at the optimum NRL replacement ratio and the optimum NRL replacement ratio reduces with the input of cement and is equal to 20%, 15% and 10% for C = 3%, 5% and 7%, respectively.

The total deformation for each loading cycle is the sum of elastic (recoverable) and plastic deformation. The accumulation of plastic deformation results in excessive deformation, and subsequently the permanent deformation. **Figure 1** present the accumulated total, elastic and plastic deformations prior to failure (within zone 1 and zone 2) of cement and cement-NRL stabilized Soil. Cement-NRL stabilized samples exhibits higher total deformation, the plastic deformation is lower, and the elastic deformation is higher when compared to the cement stabilized sample. This indicated that the NRL replacement improved the capacity to withstand the developed plastic strain against fatigue.

The SEM image (**Fig. 2**) shows that the latex film infiltrates the pore space and reduces the porosity. The microcracks are coated with interconnected films covering soil particles under hydration. Moreover, the coating of the latex network

[1] Professor, Suranaree University of Technology, THAILAND, suksun@g.sut.ac.th
[2] Lecturer, Suranaree University of Technology, THAILAND, apinun_ce@hotmail.com
[3] Associate Professor, Suranaree University of Technology, THAILAND, menglim@g.sut.ac.th
[4] Researcher, Suranaree University of Technology, THAILAND, suddeepong@g.sut.ac.th
[5] Researcher, Suranaree University of Technology, THAILAND, artit.u@g.sut.ac.th
[6] Lecturer, Suranaree University of Technology, THAILAND, teerasakyaowarat@gmail.com
[7] Professor, Swinburne University of Technology, AUSTRALIA, aarulrajah@swin.edu.au

acts as a barrier-like reaction, which inhibits water absorption during the hydration process. Therefore, it can be concluded that at a low cement content, the hydration slightly affects the strength development, and therefore, the NRL replacement plays a significant role in the strength development by enhancing the latex network in the soil-cement matrix. As such, the cement-stabilized soil sample at the very high 30% NRL replacement ratio still has a higher mechanical properties value than the sample without the NRL. While at high cement contents (5% and 7%), the mechanical properties value contribution is strongly from the cementation bonding. Although the latex film can enhance the adhesion of the soil-cement matrix, at the same time, it retards the cement hydration. Hence, the optimum NRL replacement ratio reduces with increasing the cement content.

The CO_2-e emission for the cement-NRL stabilized soil is lower than that for the cement stabilized soil at practically the same ITS, which is 19.70%, 27.36%, 30.72%, 19.18%, and 6.24% for NRL replacement ratios of 10%, 15%, 20%, 25%, and 30%, respectively. From the results of mechanical test and CO_2-e emission evaluation, the NRL is considered as an environmentally friendly additive for cement stabilization.

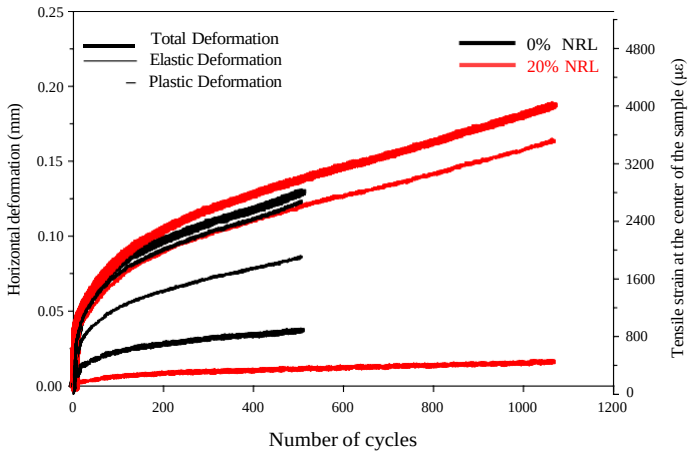


Fig. 1. Total, elastic, and plastic deformations in zone 1 and zone 2 for cement-NRL stabilized samples and cement stabilized samples (Buritatum et al., 2022).

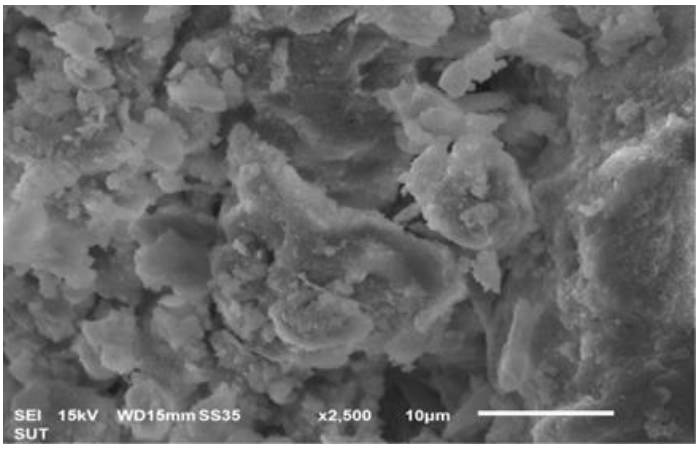


Fig. 2. SEM images of NRL-cement stabilized sample (Buritatum et al., 2020).

References

Buritatum, A., Suddeepong, A., Horpibulsuk, S., Udomchai, A., Arulrajah, A., Mohammadinia, A., and Hoy, M., 2022: Improvement of tensile properties of cement-stabilized soil using natural rubber latex. Journal of Materials in Civil Engineering, **34**(*4*), 04022028.

Buritatum, A., Takaikaew, T., Horpibulsuk, S., Udomchai, A., Hoy, M., Vichitcholchai, N., and Arulrajah, A., 2020: Mechanical strength improvement of cement-stabilized soil using natural rubber latex for pavement base applications. Journal of Materials in Civil Engineering, **32**(*12*), 04020372.

Rockfall: Prediction, Prevention, and Mitigation

Trilok Nath Singh

ABSTRACT

Rockfall Phenomenon is very regular in high hills. It poses serious problem for safety, stability and sustainability of human being.

This Phenomenon is recurrent and many times it blocks the traffic and harms the human settlement. The Himalaya is very prone to rockfall due to its high hills and seismic zones. Sometime, widening of road creation of new infrastructure, natural resource utilization is the main driver for risk associated with it. Every year the loss of life is increasing and there is need to have a scientific approach to minimize it.

The variation in geological setting, complex structural setup variability of geomechanical parameters, steep slope angle, heavy rain intensity, many more parameters control the rockfall in a particular site.

To suggest and design the rockfall protection to prevent the detachment of rock blocks, a detail and in-depth study is required.

In this paper, an attempt has been made to discuss various problems relevant to rockfall activation in highly complex and critical geological rockmass condition. A few relevant case studied will be discussed to explain how bounce height, travel mode, energy (Kinetic and Potential) and translation velocity influence the rockfall barrier design. Based on outcome suitable, cost effective preventive measure will be suggested to arrest the rockfall hazard in future.

Professor, Department of Civil and Environmental Engineering, Indian Institute of Technology Patna, Bihta-801106, Bihar, INDIA; tnsiitb2@gmail.com

Climate Change Ramifications Focusing on Recent Heavy Rainfall-induced Geo-disasters in Kyushu Island, Japan

Noriyuki Yasufuku[1] and Adel Alowiasy [2]

ABS T RA CT

Recently, heavy rainfall events have been inducing devastating geo-disasters, floods, sediments, and debris flows in different regions around Japan, causing severe damage to lives and properties. According to the Intergovernmental Panel on Climate Change (IPCC), the frequency and intensity of localized torrential rainfall events are expected to increase. This study initially highlights the increasing geo-disaster-inducing forces in relation to the deterioration of the social infrastructure and the decline in the labor forces in Japan. Furthermore, several geo-disasters within Kyushu Island, Japan, which seem to occur repeatedly, were analyzed considering the prevailing conditions and the adopted mitigation and prevention protocols. Consequently, the necessity for developing innovative systems and techniques that integrate the academic disciplines in collaboration with the residents and the government was asserted. Moreover, recent progress in establishing comprehensive geo-hazard vulnerability assessment methods and techniques that consider the regional characteristics, mainly of the Kyushu and Hokkaido Islands, was introduced.

On the 5th and 6th of July 2017, a heavy rainfall storm struck Northern Kyushu Island, Japan. The storm mainly affected the northern parts of Fukuoka prefecture (Asakura City) and the Oita prefecture (Hita region). The storm, which the Japanese Meteorological Agency (JMA) named "Northern Kyushu heavy rainfall in July 2017", has caused severe damage to the mountainous area extending between Asakura city and Hita region (**Fig. 1**). 12-hours cumulative precipitation of 511.5, 329.5, and 532 mm were recorded at Asakura meteorological agency observatory, Hita rainfall observation center, and Tsurukawauchi rainfall observatory, respectively. The latter was confirmed to significantly exceed the cumulative precipitation of Kyushu Island's heavy rainfall events in 2009 and 2012 (JGS 2010; 2013; 2018). Consequently, geo-disasters occurred within the affected area, including mud and debris flows and landslides.

Several large-scale slope failure cases were reported, including failure of the top parts of the slopes, scouring, and failure of the beds and shores in the middle basin. It must be noted that the ground is mainly comprised of severely weathered granodiorite and metamorphic rocks. Consequently, large amounts of sediments and driftwood have flooded and accumulated in the downstream region, spreading over private houses and farmlands, causing extensive sediments, driftwood, and water-induced damage to lives and properties, as illustrated in **Fig. 2**. Immediately, an investigation team was formed to investigate the affected mountainous area. The team investigated the prevailing situation and conducted various geotechnical tests to define the affected area's soil mechanical and hydrological characteristics.

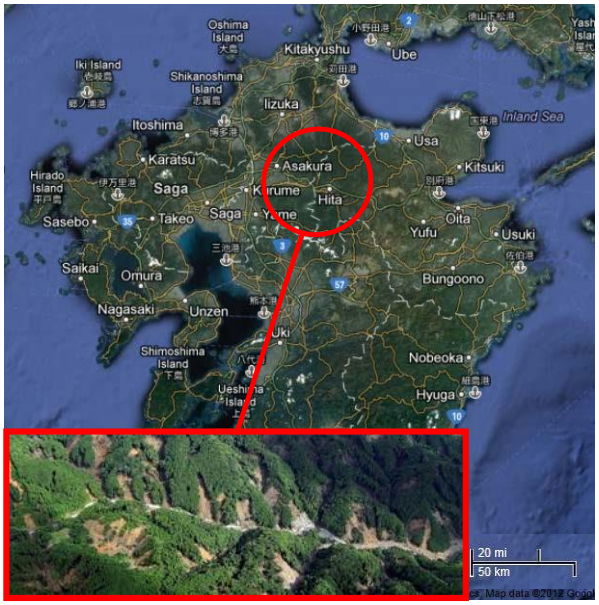


Fig. 1 Mountainous area location of the northern Kyushu heavy rainfall-induced geo-disasters, July 2017. [Chikugo river report, 2017]

[1] Emeritus Professor at Kyushu University, Fukuoka, JAPAN, yasufuku.noriyuki.691@m.kyushu-u.ac.jp
[2] Assistant professor at Kyushu University, Fukuoka, JAPAN, a.adel@civil.kyushu-u.ac.jp

The ultimate priority in large-scale geo-disasters is to prevent injuries and fatalities. Several approaches to protecting human lives were developed, such as constructing infrastructures like Sabo dams. However, novel and innovative approaches are needed considering the current rainfall patterns, the variations in the scale and type of the impacts, and the adopted countermeasures. Those approaches are better based on soft measures such as "an evacuation warning system" and "restrictions on land use" to protect human life and define vulnerable zones.

This lecture comprehensively introduces the recent heavy rainfall-induced geo-disaster in Japan, especially in Kyushu Island. The cases are analyzed, and a group of learned lessons is delineated. It provides a fundamental database for effective preparations for future similar geo-disasters subjected to similar external forces. Furthermore, technical obstacles and new approaches to deal with such events are elaborated on from a geotechnical and geological point of view. The term "geo-disaster" is used in this context to describe various slope disasters, including debris flows, driftwood, slope failures, landslides, and embankment damages. The study revealed a strong correlation between cumulative precipitation and the scale of the geo-disaster, especially in terms of the amount of generated sediments.

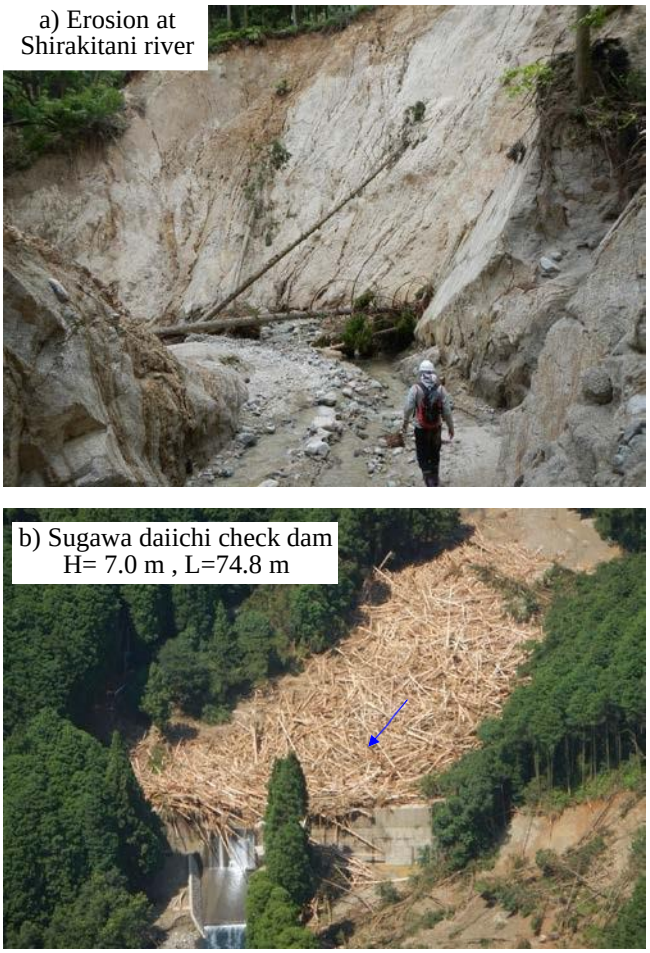


Fig. 2. (a) Typical erosion at Shirakitani river, (b) catchment of driftwood by check dam. [JGS, 2018]

References

Japan Geotechnical Society [JGS], 2010:. Report on “Geodisasters in 2009 July Northern Kyushu and Chugoku region torrential rainfall (Representative member: Noriyuki Yasufuku)”. (in Japanese)

Japan Geotechnical Society [JGS], 2013:. Report on “Geodisasters in 2012 July Northern Kyushu torrential rainfall (Representative member: Noriyuki Yasufuku)”. (in Japanese)

Japan Geotechnical Society [JGS], 2018: Report on “Geodisasters in 2017 July Northern Kyushu torrential rainfall (Representative member: Noriyuki Yasufuku)”. (in Japanese)

Application of Multi-Hazard Risk Assessment for Preparing Risk Sensitive Land Use Plan: A Case Study to Cope with Geo-Disaster for Resilient Society

Suman Manandhar [1], Habendra Prasad Dev [2] and Bishal Dev [3]

ABSTRACT

The multi-hazard risk assessment (MHRA) in the Kailali District of the Far Western Province is a crucial part of the Risk Sensitive Land Use Planning (RSLUP) initiative, as mandated by the DRRM Act of 2017. This assessment aims to aid in the development of RSLUP by utilizing both qualitative and quantitative methods encompassing the collection of primary and secondary data through site visits and laboratory analyses. Field hazard mapping, household surveys and institutional surveys, in-situ soil testing, collection of soil samples in a grid and laboratory test were adopted for the multi-hazard risk assessment. Besides, records of historical hazard events were carried out during the field survey.

The field and laboratory results were then assessed for analytical evaluation using various well-established scientific tools. These results were subsequently represented in the map using geospatial tools. For instance, OpenLISEM was utilized for flood hazard analysis, while existing literature was referenced for earthquake hazard assessment. Statistical and heuristic methods were applied for landslide susceptibility mapping, and global satellite datasets were used to evaluate wind hazards. Spatial Multi-Criteria Evaluation (SMCE) in GIS was employed for mapping animal attack and fire susceptibility and globally recognized climate indices were utilized to assess climate extremes. Additionally, elements-at-risk data, including information on buildings, population, agricultural areas and roads, were integrated into the analysis. To provide a comprehensive overview, an exposure assessment was conducted for all relevant hazard types, elements-at-risk, and administrative units, ensuring a detailed understanding of potential impacts across different scenarios.

In this study, two municipalities, Lamkichuha Municipality and Godawari Municipality were considered as the pilot study. A comprehensive hazard map was produced by integrating various hazard types to identify areas with the highest hazard levels. This was achieved using a Spatial Multi-Criteria Evaluation (SMCE) approach, where a criteria tree was constructed encompassing all hazard maps. Hazard classes were assigned specific weights: **high hazard (1)**, **moderate hazard (0.5)**, and **low or no hazard (0)** and indicated by ***red***, ***yellow*** and ***green*** colours respectively on the multi-hazard map (**Fig. 1**) as an example from Lamkichuha Municipality (Manandhar et. al., 2022).

The results of the MHRA needs to be overlaid on the current land use data, considering existing population growth and projected urban expansion. The study was carried out to project the anticipated future urban development trends for two periods: up to 2030, and from 2031 to 2050. The 'nodal development' concept is tailored to the scale, dimension, settlement patterns, connectivity and available social infrastructure within defined boundaries utilizing land use zoning that follows safer zones. ***Primary***, ***Secondary***, and ***Tertiary*** Development Nodes are recommended based on current urban sprawl and projected future growth trends. **Figure 2** represents the master plan of Development Nodes for 2030 and 2050 AD on the developed multi-hazard map of Godawari Municipality (Manandhar et al., 2023).

Thus, the implementation of MHRA plays a crucial role in identifying safer and more resilient zones within an area. This process is instrumental in developing a Risk Sensitive Land Use Plan (RSLUP), which is essential for creating a well-structured and meticulously planned city. By pinpointing areas that are less vulnerable to various hazards, MHRA enables urban planners to allocate resources and design infrastructure in a manner that minimizes risk and enhances the overall resilience of the urban environment. Consequently, this approach not only contributes to the safety and sustainability of the city but also ensures that future urban development is both strategic and informed by comprehensive hazard assessments.

[1] Research Fellow, Global Institute for Interdisciplinary Studies, NEPAL, geosuman27@gmail.com
[2] CEO, Rajdevi Engineering Consultant P. Ltd., NEPAL, devhabendra@gmail.com>y
[3] Director, Rajdevi Engineering Consultant P. Ltd., NEPAL, thebishaldev@gmail.com

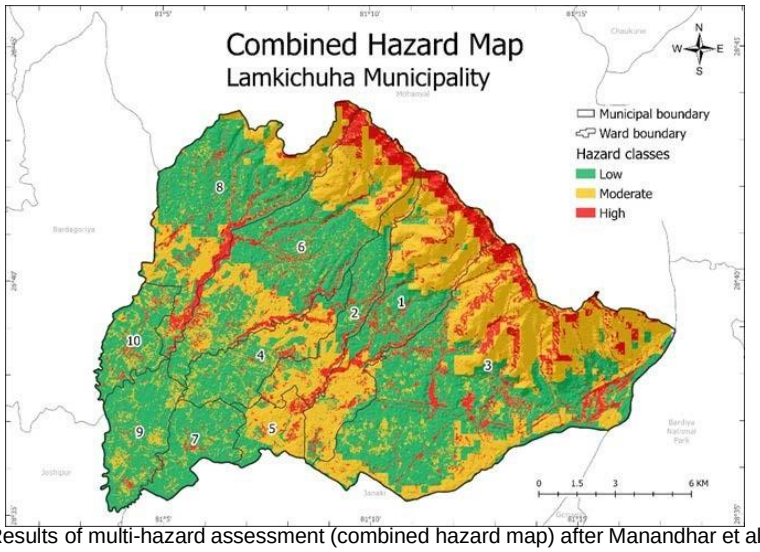


Fig. 1. Results of multi-hazard assessment (combined hazard map) after Manandhar et al., 2022.

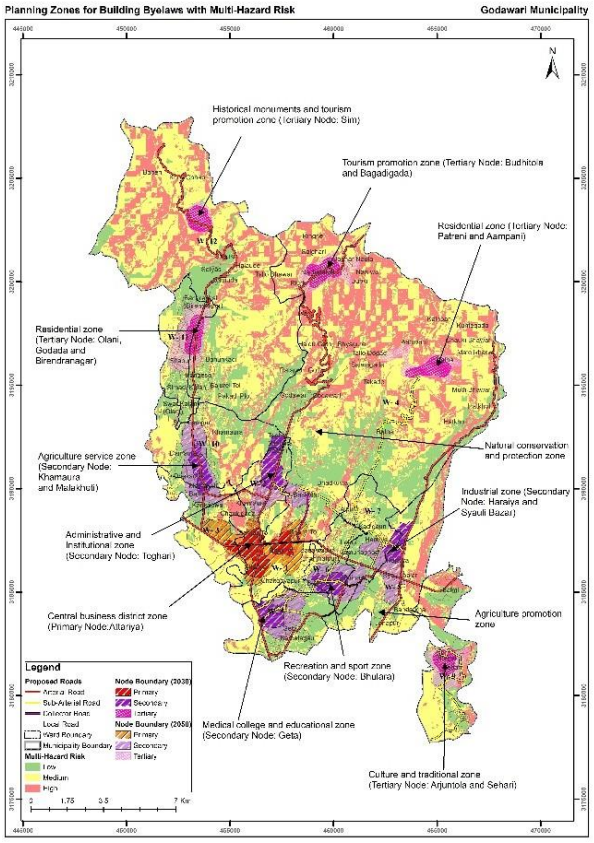


Fig. 2. Master Plan of Development Nodes for 2030 and 2050 AD on combined multi-hazard map of Godawari Municipality after Manandhar et al., 2023.

References

MOHA (Ministry of Home Affairs), DRRM Act, 2017.

Manandhar, S., Shrestha, B.K. and Dev, B., 2023: Application of Multi Hazard Risk Assessment for the Preparation of Risk Sensitive Land Use Plan (RSLUP) adopting DRRM: A Case Study of Lamkichuha Municipality, Sudur Paschim Province, Nepal. Proc. Of 16th ICCEM, 2022: 1-8.

Manandhar, S., Dev, H.P. and Dev, B., 2023: Multi-hazard Risk Assessment for Developing Risk Sensitive Land Use Plan using Geospatial Tools: A Pilot Project from Godawari Municipality, Sudur Paschim Province, Nepal. Proc. Of FIG Commission, May 2023: 1-14.

Geotechnical Opportunities in Ontario, Canada

Reza Mahmoudipour

ABSTRACT

Ontario, Canada, stands as a beacon of growth and development, driven by its ambitious infrastructure projects and diverse geological landscape. As a geotechnical engineer, exploring the opportunities within this region offers a unique blend of challenges and rewards. This presentation aims to highlight the top infrastructure projects in Ontario and discuss the emerging opportunities for geotechnical professionals in these ventures.

Top Infrastructure Projects in Ontario:

Ontario is home to numerous high-profile infrastructure projects, as highlighted in the "Top 100 Projects 2024" report. Key projects include:

1. Ontario Line Subway Project: This project represents a significant expansion of Toronto's subway system, addressing the city's growing transportation needs.
2. Eglinton Crosstown LRT: A major light rail transit project designed to improve transit efficiency and connectivity in Toronto.
3. Gordie Howe International Bridge: An essential cross-border infrastructure project connecting Windsor, Ontario, to Detroit, Michigan, which will enhance trade and transportation.
4. Don River and Central Waterfront Project: This project focuses on flood protection and revitalization of Toronto's waterfront, combining environmental sustainability with urban development.
5. Bruce Power Refurbishment: A significant energy project aimed at extending the life of nuclear reactors, ensuring a stable energy supply for Ontario.

Geotechnical Challenges and Opportunities:

Each of these projects presents unique geotechnical challenges, offering numerous opportunities for engineers to apply their expertise:

1. Subsurface Investigations: Accurate soil and rock sampling are crucial for foundation design, slope stability, and overall site safety. Engineers have the opportunity to develop innovative sampling techniques and improve data accuracy.
2. Foundation Design: Projects like the Ontario Line and Eglinton Crosstown LRT require robust foundation solutions to support heavy infrastructure in varied geological conditions, providing a platform for creative engineering solutions.
3. Tunnel Construction: The construction of subways and other underground structures involves advanced tunneling techniques and ground support systems. Engineers can explore cutting-edge technologies in tunnel boring and ground stabilization.
4. Environmental Considerations: The Don River and Central Waterfront Project emphasizes the integration of flood protection with urban development, offering opportunities to work on projects that balance engineering needs with environmental sustainability.
5. Seismic and Stability Assessments: With projects such as the Bruce Power Refurbishment, engineers must conduct rigorous seismic assessments to ensure the stability and safety of nuclear facilities.

P.Eng., Englobe, Toronto, Canada, Mahmoudipour@gmail.com

Conclusion

Ontario's dynamic infrastructure landscape presents a wealth of opportunities for geotechnical engineers. By engaging in these high-profile projects, professionals can contribute to the region's growth while advancing their technical skills and knowledge. This presentation will delve deeper into these projects, discussing the specific geotechnical challenges and potential solutions, thereby highlighting the critical role of geotechnical engineering in Ontario’s future development.

Keywords:
Geotechnical Engineering, Subsurface Investigations, Foundation Design, Tunnel Construction, Environmental Sustainability, Seismic Assessments.

The Liquefaction-Induced Large Scale Flow Slide in Loess Deposit During the Jishishan 6.2 Earthquake and its Risk Zonation

Lanmin Wang [1], Shiyang Xu [2], Ping Wang [3], Qian Wang [4] , Xiaowu Pu [5] and Shaofeng Chai [6]

ABSTRACT

At 23:59 of December 18, 2023, a strong earthquake with a magnitude of M6.2 struck Jishishan county with a focal depth of 10km, in Gansu province, China, where is the transition zone between Qinghai-Tibet Plateau and the Loess Plateau. The epicenter is located at N35.70° and E102.79°, which is about 100 km southwest away from Lanzhou, the capital city of Gansu province. The earthquake caused 151 people dead and 979 people wounded in Gansu and Qinghai provinces. Many buildings and houses damaged seriously, and some old houses collapsed in the meizoseismal region. The preliminary investigation shown that such a serious disaster attributed to three major extraordinary factors: very big ground motion acceleration, a liquefaction-triggered large-scale flow slide in loess deposit and the event occurring at midnight in the winter.

During the earthquake, a large-scale liquefaction-triggered flow slide in loess deposit on the secondary terrace with a gentle slope of 2°-3.5° of the Yellow River, which buried 51 houses in two villages and killed 20 people. In this paper, the characteristics of the large-scale flow slide were introduced based on a reconnaissance field investigation on the mud flow. The mechanism of the liquefaction-triggered flow slide in loess deposit was analyzed. The susceptibility of such kind of liquefaction-triggered flow slides in the Loess Plateau was assessed with a zonation map.

The investigation shown that fast starting, high-speed flow sliding, large-scale and gentle slope are the four main characteristics of the large-scale flow slide of loess deposit. The onset of liquefaction in loess deposit was triggered in a large area by the earthquake after 7.8 seconds during the main shock based on the dynamic triaxial tests of saturated loess specimens secured from the in-situ site shown in **Table 1**. The mud flow appeared at the first house around 60 seconds after the main shock, where is 560 m from the exit of the liquefied area. The flow speed is estimated around 10 m/s. The mud flow arrived at the archway of Caitan village in about 6 minutes after the main shock, where is 1740 m from the exit of liquefied area (**Fig. 1** and **Fig. 2**). For the whole process of flow slide, the average velocity is about 5 m/s. The flow slide shown a large scale in both the sliding mass of 1.5-2.0 million m^3 and the long moving distance of 2.5 km. The topographies both in the liquefied area and in the flowing gully are very gentle slopes of 1.5°-5° (**Fig. 3**).

The investigation shown that the large-scale flow slide in loess deposit was triggered by liquefaction in 11m deep saturated loess deposit under the shaking with a PGA around 400 gals during the Jishishan 6.2 earthquake on December 18, 2023. The overburden loess slid down with the gentle slope of 2°-3.5° along the liquefied zone into a gully with a slope of 1.5°-5°. During the flow sliding, the overburden unsaturated loess mixed with water coming from underground liquefied zone and top soil with high water content, and finally developed into a large- scale mud flow. Such a kind of liquefaction-triggered flow slide in loess deposit also appeared during the Tajik 5.5 earthquake in 1989 (Ishihara, et al,1990) and the Haiyuan 8.5 earthquake in 1920 (Bai et al, 1990). The zonation map of susceptibility of liquefaction-induced landslides in the Loess plateau shows a high risk of the flow slide under rare earthquakes (**Fig. 4**).

[1] Professor, Lanzhou institute of Seismology, China Earthquake Administration, Lanzhou, China, wanglm2304@126.com
[2] Associate professor, Lanzhou institute of Seismology, China Earthquake Administration, Lanzhou, China, 290123116@qq.com
[3] Professor, Lanzhou institute of Seismology, China Earthquake Administration, Lanzhou, China, lanzhouwang_p@126.com
[4] Professor, Lanzhou institute of Seismology, China Earthquake Administration, Lanzhou, China, wangq0930@126.com
[5] Associate professor, Lanzhou institute of Seismology, China Earthquake Administration, Lanzhou, China, wdpuxw@163.com
[6] Associate professor, Lanzhou institute of Seismology, China Earthquake Administration, Lanzhou, China, chaishaofeng520@163.com

Table 1. The time sequences of events in the Jishishan 6.2 earthquake in December 18, 2023.

Time	20 40 60 (sec) 1 2 3 10 (min) 30
Resource Area	12.8 — 42 Intense shaking (recorded); 1'30" — 6 Flow slide; 19.8 ← Onset of liquefaction (tested)
The First house (at the down) 560m downstream	15 — 55 Intense vertical shaking Including twice voilent vertical shakings (felt); 1'55" — 7'55" Flow slide; 2'55" ← The glare of Fire and explosion caused by damage of power pylon
The Archway of Caotan Village 1740m downstream	15 — 55 Intense vertical shaking Including twice voilent vertical shakings (felt); 7'55" — 30 Flow slide; 2'55" ← The glare of Fire and explosion caused by damage of power pylon

Fig. 1. The archway of Caotan village just removed the buried mud of 3 m.

Fig. 2. Jintian village (right bank) and Caotan (left bank) buried by the mudflow of 2-5 m.

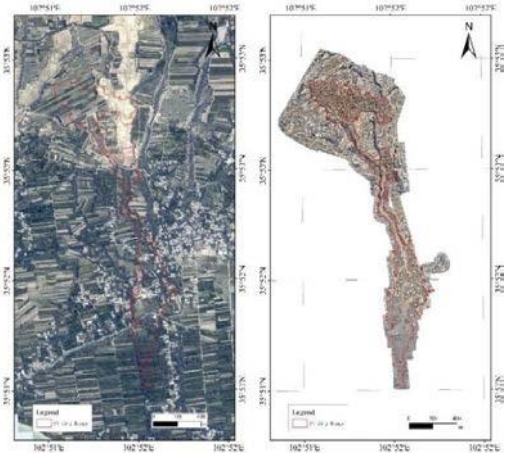


Fig. 3. The topography of liquefaction-induced mudflow site before (left) and after (right) the Jishishan M6.2 earthquake.

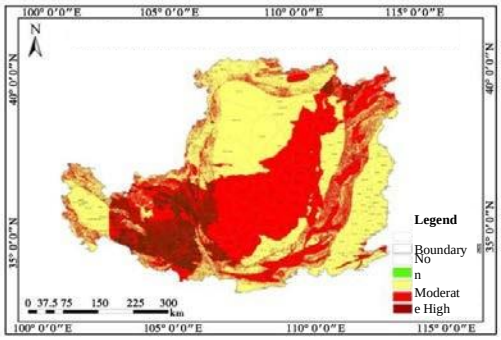


Fig. 4. The zonation map of susceptibility of liquefaction-induced flow slides in the Loess Plateau under rare earthquakes with an exceedance probability of 2% in 50 years.

Acknowledgement

The research work in this paper is financially supported by The Joint Foundation on Earthquake Science of National Natural Science Foundation of China (U1939209).

References

Bai, M., Zhang, S., 1990: Liquefaction and sliding in loess strata during an earthquake with high intensity, Geotechnical Investigation & Surveying, **20**(*6*), 1-5, (in Chinese).

Ishihara, K., Okusa, S., Oyagi, N., et al., 1990: Liquefaction-induced flow slide in the collapsible loess deposit in soviet Tajik. Soils and Foundations, **30**(*4*), 73-89.

Lowering the Groundwater Table and Promoting Consolidation of Soft Soils by Negative Pressure Loading Using the Super Well Point (SWP) Method

Masayuki Hyodo [1] and Shigeyoshi Takahashi [2]

ABSTRACT

The structure of the Super Well Point method consists of a steel pipe well of approximately 40 cm diameter, a submersible pump mounted near the bottom of the well and a vacuum pump at the top of the well. The submersible pump pumps up the water in the well and at the same time the vacuum pump at the top of the well adds vacuum pressure through a vent at the bottom of the well and through a filter wrapped around the well, creating a strong negative pressure in the ground and causing cavitation in the ground, sucking in groundwater and reducing the water content of the surrounding soil. First, a hole of about 80 cm in diameter is drilled, a casing is erected, an SWP well is inserted and boulders are placed around it. The casing is pulled out and pressurised to 80 kPa by a SWP compressor. Negative pressure is then applied and this process is repeated to clean the ground around the well and create numerous channels in the ground. This process creates natural flutter as gravel and sand with large grain sizes gather around the well at high flow velocities. A vacuum pump at the top of the well can then pump up the groundwater to promote groundwater lowering and consolidation of the soft ground. SWP has been used to lower groundwater levels in river estuary sluice gates, tunnel construction, building foundations, river channel construction, spring pond widening and landslide control, and has also been used to promote consolidation of soft ground. This presentation will outline the mechanisms by which SWP can be used to lower groundwater levels and promote consolidation, as well as specific examples of construction works.

[1] Emeritus Professor, Yamaguchi University, JAPAN, hyodo@yamaguchi-u.ac.jp
[2] President, Asahitechno, Co., Ltd., JAPAN, arandoron-2973@s9.dion.ne.jp

Disaster Gerontology Perspective on Disaster Risk and Crisis for Older Adults

Keiko Kitagawa

ABSTRACT

Gerontological Approaches to Disaster Risk and Crisis Management for Older Adults Vulnerable to Disasters Whenever a major natural disaster occurs, many of those who become victims or are affected are older adults. This has been recognized in the field of crisis management studies, and appropriate responses for older adults have been attempted, but gerontological knowledge has not been utilized in this perspective.

In fact, gerontological research on disasters has only been conducted for more than a decade. In Japan, research on disaster gerontology is still lacking. Therefore, in this research, I would like to refer to disaster gerontology by utilizing the knowledge of gerontology.

Gerontology is the study of old age and aging and the social, cultural, psychological, cognitive, and biological aspects of aging. The word was coined by Ilya Ilyich Mechnikov in 1903, from the Greek γέρων (gérōn), meaning is "old man", and -λογία (-logía), meaning is "study of". The field is distinguished from geriatrics, that specializes in the treatment of existing disease in older adults. Gerontologists include researchers and practitioners in the fields of biology, nursing, medicine, criminology, dentistry, social work, physical and occupational therapy, psychology, psychiatry, sociology, economics, political science, architecture, geography, pharmacy, public health, housing, and anthropology (Hooyman, N.R. Kiyak, H.A., 2011).

The interdisciplinary and multidisciplinary nature of gerontology means that there are many subfields that overlap with gerontology. Examples include policy issues related to administrative planning and nursing home operations, research on the impact of aging on society, and the design of residential environments for the elderly that foster a sense of place and home.

The field of gerontological research is only 80 years old, the USC Leonard Davis School of Gerontology established the first doctoral, master's, and bachelor's programs in gerontology in 1975. Thus, it is fair to say that the training of researchers in gerontology really began in the 1970s.

This study is based on the "synthesis of knowledge or knowledge integration, approach from Gerontology in interdisciplinary disaster risk and crisis management research. Over the years, we have conducted collaborative research on disaster prevention, mitigation, and recovery. A disaster gerontology perspective is critical to our crisis/risk management research process.

In general, disaster risk/crisis management involves identifying the potential risks and hazards that may arise from natural disasters, industrial accidents, or civil emergencies, and taking steps to mitigate these risks and protect the affected populations. When it comes to gerontology, disaster risk management involves understanding the unique needs and vulnerabilities of older adults during a crisis situation, and developing strategies to meet these needs and ensure these individuals receive the care and support they require.

In Japan, unlike other countries, the occurrence of disaster-related deaths is unique. In the 2011 Great East Japan Earthquake, 3,794 associated deaths were identified. Of the 1,263 deaths analyzed by the Reconstruction Agency in 2012, one year after the disaster, about 90% were elderly people aged 70 or older. In the Great East Japan Earthquake, 18% of the above 1263 people died within a week, 48% within a month, and 78% within three months. The most common causes of death were respiratory and cardio-respiratory diseases, which together accounted for 60% of the total.

The basic principle of Japan's disaster response is the same as that of the United States: "Leave no one behind. Indeed, the emphasis has been on evacuating the older adults, people with disabilities, children, and pregnant and

Professor Emeritus, Saga University, Visiting professor, Meiji International Medical Science University, JAPAN, kitagawa2214@gmail.com

nursing mothers to protect their lives, and in fact, the number of deaths has been low even after major earthquakes and disasters. However, the number of deaths due to poor health after staying in evacuation centers or moving to temporary housing is often higher than the number of direct deaths during disasters. This is a major challenge during disasters in Japan.

References

Stuart-Hamilton, I., 2012: Different Views of Later Life, An Introduction to Gerontology Cambridge University Press, 2011 15-19, Anthea Tinker*, Technology and Ageing*, An Introduction to Gerontology Cambridge university Press, 2011363-388, Ehren B. Ngo, *Elderly and Disaster,* The Routledge Handbook of Hazards and Disaster Risk Reduction, Routledge 2012: 447-469.

Thorson, J.A., 2000: The End of Life, Aging in Changing Society. Tailor & Francis, 2000: 277-304.

Lieberman, M.H., 1991. Relocation of the Frail Elderly. The Physical World and Quality of Life in the Frail Elderly, Academic Press: 120-141.

Kitagawa, K. and Mizuno, M., 2023: Disaster Prevention/Mitigation, Response and Recovery for Protecting People's Safety and Health as Sustainable Society. Risk-Based Approaches to Sustainable Development Meeting, Mongolia.

Seol, A.K., Park, K. and Choi, H.G. 2023: An Examination of the Need for Underground Path Safety Assessment Technology in Response to the Climate Crisis. 2023 Risk-Based Approaches to Sustainable Development Meeting, Mongolia.

Kitagawa, K., 2023. Disaster Vulnerability of Disabilities and Supporting Volunteers in Depopulated Area in Japan-Need to Eliminate Normalcy Bias Against People with Disabilities for Useful Social Capital for Mutual Aid in Disasters-ODISHA. Journal of Social Science.

Kitagawa, K., Lee, J.E. and Dong-Kyun, Y., 2022. Public and Community Concerns Disabilities for Eco-Friendly Recovery from Mega natural Disasters. Proceedings of Asian Association for Crisisonomy.

Ganchimeg, B.E., Lee, J.E. and Kitagawa, K., 2022: Comparative Analysis of Covid-19 Pandemic Response, Korea, USA, Japan, Germany and France. Journal of Safety and Crisis Management, **30**.

Kitagawa, K., Lee, J.E. and Chen, A., 2022: Using Social Capital Theory to Overcome Normality Bias and Examine Risk/Crisis Management for Mega and Complex Disasters. Asian Association for Crisisonomy.

Kitagawa, K., Lee, J.E., Chen, A. and Noh, H.W., 2021: A Research on the Evacuation for People with Disabilities to Minimize the Damage by Urban Mega Disasters -The Case of Japan. Asian Association for Crisisonomy.

Kitagawa, K., 2020: Rethinking of School Facilities as Evacuation Shelters. Welfare Learning Support Study, **1**(*1*).

Lee, J.E., Kim, D., Chen, A., Kitagawa, K. and Noh, H.W., Jeong, Sharma, G., Muhammad, A., Minsun, S. and Longtian, A., 2020: Disaster Preparedness, Vulnerability and Resilience: Review of Theories and Implementations. Crisisonomy,**16**(*5*): 133-154.

Kim, S., Seol. A.K., Lee, J.E., Ahn, B.C., Lee, J.H., Chen, A., Kitagawa, K. Kim, D., and Wang, J., 2020: Analyzing the Role of Resource Factors in Citizen' Intention to Pay for and Participate in Disaster Management. Sustainability,**12**(*8*), 1-24.

Kitagawa, K., Lee, J.E., Noh, H.W.2017: Diversity in Disaster Education and Concerning Foreign Residents at Times of Disaster. Journal of Safety and Crisis Management,**7**(*2*):7-17.

Lee, J.E., 2023: Disaster Resilience Model for Establishing the Sustainable Society in the Era of Climate Crisis. Journal of Safety and Crisis management,**13**(*6*), 1-10.

Seol, A.K. and Ryu, S.I., 2022: What Role Do Disaster Victims Play as the Mainstream for Future Disaster Preparedness in Korea? Case Study and Victims' Families. A Semantic Network Analysis, Social Sciences.

Noh, H.Wo, Chung, Y.J., Kitagawa, K. and Sakamoto,2017: Development of Variable Air Mattresses for Shelter based on Disaster Prevention Design. Crisis and Emergency Management, Theory and Praxis, CEMTP.

Noh, H.W. and Kitagawa, K., 2017: A Study on the Improvement of Disaster Prevention Design Based on Toilet in Ger Area, Mongolia. Korea Content of Association.

Sustainable Practices in Civil Engineering

Catherine N. Mulligan

ABSTRACT

Due to depletion of natural resources, increased natural disasters, waste, greenhouse gas and pollutant generation, environmental deterioration, and loss of biodiversity, civil engineers are facing new challenges. Sustainable engineering is the process of designing systems that do not compromise the environment and the ability of the present and future generations to meet their own needs. New ways of thinking are required to develop new solutions. Incorporating sustainability into engineering design has only recently been initiated due to significant challenges. Environmental, economic and social aspects must all be integrated into the designs. This presentation will examine some of the tools and case studies currently available for implementation of sustainable practices into civil projects. While it is generally believed that the concepts of sustainable development must be followed for protecting future generations, it is much easier said than implemented. Therefore, the focus of this presentation will be to focus on the application of the principles of sustainable engineering to projects and processes through case studies and examples of sustainable practices.

Various frameworks have been developed to facilitate sustainability. Some include the Global Reporting Initiative (GRI), and the triple bottom line. The triple bottom line includes the three aspects of environmental, social and economic. It has been used for measuring sustainability performance for a region or business. Without measurements, sustainability is only a vague concept to many that cannot be realized. Indicators are often used to measure progress. They are data that can be measured to describe a condition or trend. Some indicators include waste recycling rates, water and energy consumed, employment rates, greenhouse gas emissions, and water quality. For sustainability purposes, social and economic indicators are also required. The Global Reporting Initiative has been used widely for organizations of any size for measuring and reporting on the environmental, economic and social dimensions via various indicators. Performance indicators cover environmental, social and economic aspects. Elements of the reports include the organization description, management approach, indicators employed, the impacts and boundaries and management of the impact.

To mitigate climate change, materials can be selected that contain less embodied carbon. An example is the new type of geosynthetics, Geosynthetic Cementitious Composite Mat (GCCM), named Concrete Canvas® (CC). It is a factory-assembled geosynthetic composite with a cementitious layer and one or multiple layers of geosynthetic materials. The cementitious portion becomes hardened upon hydration. It can be used in various applications such as erosion control and weed suppression, ditch lining, slope, outfall, pipe or spillway protection and stabilization, lining of culverts and bunds, concrete remediation, and mining vent walls. and needs for the future will be included. Carbonate cementing of granular soil particles in diagenesis could be used as a soil improvement technique that is robust and durable soft ground. However, the rate of the natural process is very slow for practical applications. Therefore, an artificially induced diagenesis could be a sustainable solution for ground improvement. This approach would have the following advantages: (a) as it is microbially induced it would be sustainable, (b) the time frame is realistic for projects, (c) the technique is can be applied in situ and thus is economic, and durable as a soil stabilization procedure.

To calculate the emissions for projects, there are various tools available online. One of them is the free Carbon Calculator spreadsheet specific for the geotechnical industry. It was developed by the European Federation of Foundation Contractors (EFFC) and the Deep Foundations Institute (DFI) and can be downloaded from geotechnicalcarboncalculator.com. This tool is simple to use, and certified to ISO, GHG Protocol, and PAS 2050. For certification, a third party would be needed for the carbon calculations.

Another tool is a rating system such as Envision or CEEQUAL that can assist in the assessment of infrastructure project through goals and indicators. These are under continual development. Envision (ISI 2023) is used to evaluate the sustainability of infrastructure projects by designers, constructors, community groups, owners and policy makers. Bronze,

Professor, FRSC, FCAE, FEIC, FCSCE, Ph.D., Eng., Civil and Environmental Engineering, Concordia University, Director, Concordia Institute of Water, Energy and Sustainable Systems, Montreal, QC, CANAD, mulligan@civil.concordia.ca

silver, gold, and platinum levels can be obtained according to the points reached. Institute for Sustainable Infrastructure (ISI) was founded by the American Public Works Association (APWA), ASCE and the American Council of Engineering Companies (ACEC). Envision can be used for planning, design, construction and operation of various types of infrastructure projects related to airports, bridges, dams, roads, landfills and water treatment systems among others. A quick assessment can be done with a checklist for the early stages of a project. A certified evaluator must do the full assessment. In Canada, the tool is promoted by Envision Canada in partnership with the Canadian Society for Civil Engineering (CSCE).

Another example of a tool is GoldSET© (Golder Sustainability Evaluation Tool), a sustainability decision support tool for project planning and design was created by Golder Associates (now WSP Golder). It is a framework to embed sustainable development practices at various phases of any project. It has been applied for various applications such as site remediation and mining tailings around the world and includes a number of quantitative and qualitative indicators for the three sustainability dimensions, environment, society, and economy.

An important aspect is engagement. Engagement is different from consultation in form and objective. It is a process for Indigenous peoples, government and industry to share information on issues of mutual interest. Engagement can develop effective and practical relationships even when there is no duty to consult. Early engagement can help determine if there is a duty to consult and result in a more efficient consultation process. Engagement on any major development project is now an expectation of Indigenous communities. Engagements should start as early as possible in the project.

To address climate change and sustainability challenges, engineers need to work together and be more involved in decision-making at all stages of the project. They should become more involved in local or regional activities to assist in the decision making. They need to consult with stakeholders for input regarding concerns and to adapt to local conditions. Even during the construction and/or operation phases, engineers should be able to address concerns and provide advice on the sustainability of a project. Research is needed to develop innovative solutions to this changing world under the influence of climate change and increasing uncertainty, deteriorating infrastructure, introduction of new contaminants into the environment, and growing population to name a few. Engineers have an ethical requirement to rise to this challenge and thus they must be involved in sustainable engineering practices. Some tools such as carbon calculators, Envision and GOLDSET are available and are constantly being improved. Material selection is also an important and appropriate material selection can substantially reduce embodied carbon and GHG emissions. Various partnerships are needed. Engineers of various expertise needed to work together. Engagement of local communities, in particular Indigenous communities, is essential. The role of engineers in sustainable development has been undervalued but it is critical. However, action is needed now.

Community Slope Risk, Awareness and its Guideline in Penang

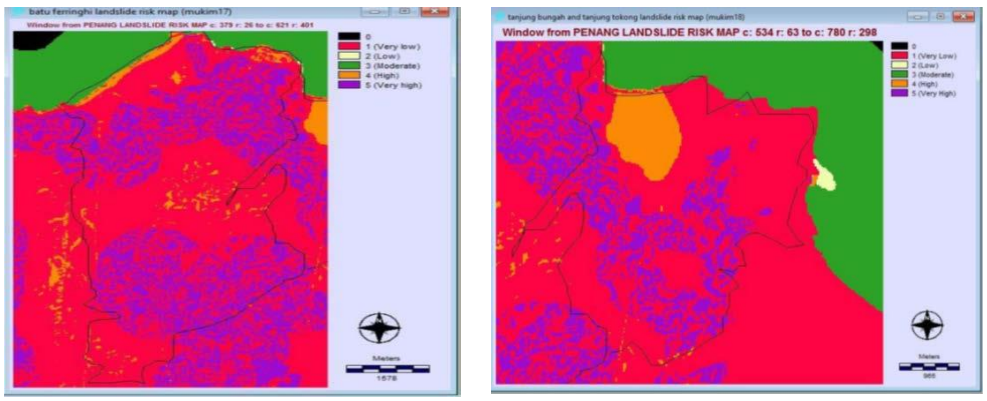
Fauziah Ahmad

ABSTRACT

Malaysia has faced a high probability of experiencing landslide disasters, particularly during rainy weather in this recent year. Continuous rainfall would result in landslide prone areas with low slope strength which may have caused increasing the possibility of landslide disasters occurring and threatening the safety of surrounding communities. Landslides in Malaysia are reported to usually occur between October and January, a period that coincides with the most amount of rainfall. In recent years, the current scenario Malaysia and due to climate change has experienced several landslide disasters resulting from heavy rainfall. Penang is one of the states in Malaysia that has been facing numerous major and medium landslide disasters. The Penang slope failures phenomenon is now at an alarming stage that requires serious consideration. Indeed, landslides have become common incidences in Penang Island as featured by the media each year. Massive hill area developments are increasing the risk of slope failure in the surrounding community. Malaysia has lost millions of Ringgits in the post-recovery process through various landslide tragedies (Abdullah 2013, Aronoff 1989 and Azmi et al, 2019)

This research aims to map community slope risk areas and to evaluate the understanding, knowledge, and awareness of the community on slope risk and landslides. The methods used are the mapping process by using GIS and community evaluation by using surveys. The findings show that the estimated community slope risk mapping is 24.71% and 20.62% of inhabitants living in high risks landslide zones in thxis two regions of Mukim 17 (Batu Feringghi) and Mukim 18 (Tanjong Bungah and Tanjong Tokong). The respondents participated in the survey and the result analysis shows that more than 50% have a strong fundamental knowledge of slope risks, while less than 50% are aware of possible landslide risks, and 42.6% will always obey an evacuation order. Overall findings show that most of the community does have a general awareness of slope risks and landslides and its guideline that have been feature in the questionnaire.

The image in **Fig.1** and **Table 1** represents two regions indicating the level the risk zone and the summary of area and population affected due to landslides analysed from the Risk Map. From the figure, the red region occupied the most area, followed by the purple, green, orange, and lastly yellow regions. The colours shown represent the level of risk of the zones, namely red for the very low-risk zone, yellow for the low-risk zone, green for the moderate-risk zone, orange for the high-risk zone, and purple for the very high-risk zone. The analysis for these parameters is summarised in Table 1. From the table, the area in Mukim 17 and Mukim 18 represented by the level of risk by the colour region and as tabulated the percentage according to the population in the particular zone



(a) Mukim 17 (Batu Feringhi) (b) Mukim 18 (Tg Bungah and Tg Tokong)

Fig. 1. Landslide risk map for Mukim 17 and Mukim 18.

Honorary Professor, Universiti Sains Malaysia, Penang, MALAYSIA, cefahmad@yahoo.com

Table 1. Summary of area and population affected due to landslides in (a) Mukim 17 and (b) Mukim 18.

(a) Mukin 17 : Batu Feringghi

No.	Colour	Area (km^2)	Population (person)	Population (%)	Zone
1	Red	34.890	19,015	61.53	Very low risk
2	Yellow	0.020	11	0.04	Low risk
3	Green	5.810	3,166	10.25	Moderate risk
4	Orange	1.971	1,074	3.48	High risk
5	Purple	14.010	7,635	24.71	Very high risk

(b) <ukim 18 : Tanjung Bungah and Tanjung Tokong

No.	Colour	Area (km^2)	Population (person)	Population (%)	Zone
1	Red	21.14	70,650	71.46	Very low risk
2	Yellow	0.023	77	0.08	Low risk
3	Green	0.810	2,707	2.74	Moderate risk
4	Orange	1.510	5,046	5.10	High risk
5	Purple	6.100	20,386	20.62	Very high risk

.

The community slope risk map for each location has identified that both Mukim 17 and Mukim 18 consist of very high-risk and high-risk zones that can affect thousands of people in the community residing there as well as those using the infrastructure in those areas as part of their daily routine. It is predicted that 24.71% out of 30,902 persons will be affected in the very high-risk zone in Mukim 17. While in Mukim 18, it is predicted that 20.62% out of 98,866 persons would be affected in the zone of very high risk. Thus, more than 50% of the population in Mukim 18 and Mukim 17 only face minimal risk from landslide occurrence. However, more precautionary and safety measures are needed to consider those residing in very high-risk and high-risk zones. It is recommended to implement more actions and strategies on slope usage to prevent losses of human lives, economic losses due to infrastructure damages, and burdensome reconstruction costs.

The evaluation of the understanding, knowledge, and awareness of the community towards slope risk and landslide are from the respondents from the community involved in this study shows that most of the communities have a general idea of landslides. To enhance their level of understanding, knowledge, and awareness of landslides and slope risk, local authorities should organise campaigns, programmes, or exhibitions that are related to landslides and slope risk. These events should be attended by all communities and the involvement of those residing in very high-risk and high-risk zones should be made compulsory. Local authorities should also conduct training sessions on community emergency responses in the event of a disaster. Local authorities could also organise workshops that require community leaders to attend. By implementing these programmes, the level of communities' understanding, knowledge, and awareness of landslides and slope risk would be enhanced, thus helping the government to address the situation Maadan, 2021 and Zimmermann, 2015). Therefore, sufficient understanding, knowledge, and awareness of landslides and slope risk amd the guidelines would help in reducing the incidence of landslides and slope risk as early signs of impending landslides can be identified by the communities at risk. The state government too have been taken various steps in assuring the communities safety and their awareness. The formation of One Stop Center of hillside development technical committee are from various agencies and experts that will scrutinised any hillside propose development before being approved. This is the main consideration they required to submit full report on their plan, analysis and any remediation in accordance to the Penang State Government Guideline.

References

Abdullah, C.H, 2013: Landslide risk management in Malaysia, WIT Transactions on the Built Environment, **133,** 255-265.

Aronoff, S., 1989: Geographic information systems: A management perspective. Geocarto International **4***:***4***,* 58.

Azimi, M. A., Zakaria, S. S. and Majid, T. A., 2019: Disaster risks from economic perspective: Malaysian scenario IOP Conference Series: Earth and Environmental Science, **244:** 012009.

Maadan, S., 2021: Causes, Effects and Types of Landslides, Earth Eclipse. Available from https://eartheclipse.com/natural-disaster/causes-effects-and-types-of-landslides.html (accessed on 21 June 2021).

Zimmermann, M. and Keiler, M., 2015: International frameworks for disaster risk reduction: Useful guidance for sustainable mountain development? Mountain Research and Development, **35***(2)*, 195-202.

Invited Lectures

Numerical and Physical Modelling of Rockfall Activities in Himalayan Region of India

Amit Kumar Verma

ABSTRACT

Rockfall poses a significant natural hazard commonly observed in the northeast region of India. This hazard involves the abrupt descent of rock blocks from cliffs at high speeds and energies, posing risks such as vehicle damage, transportation disruption, and potential injuries or fatalities. An impactful rockfall incident occurred in April 2017 along highway NH-44A near Lengpui Airport, blocking traffic for a day. Fortunately, no casualties were reported as the event transpired during nighttime. Notably, this highway serves as the sole connection between Aizawl city and the airport, highlighting the region's susceptibility to rockfall occurrences. Consequently, assessing rockfall risks along this route becomes imperative.

In this study, rockfall hazard assessment was conducted at three specific locations using the Rockfall Hazard Rating System (RHRS). Pre-failure analysis revealed that slopes with an RHRS score of 639 were deemed most hazardous, subsequently experiencing rockfall activity. Three-dimensional (3D) stability analysis employing the 3DEC software package was performed to understand failure behavior and identify rockfall-prone zones (unstable blocks) within the slope. Numerical analysis indicated a total block displacement of 2.24 cm and a velocity of 2.25 mm/s for the failed block.

Furthermore, the assessment of rockfall vulnerable zones aided in determining parameters such as run-out distance, bounce height, and energy levels of falling rock blocks. The numerical analysis revealed a maximum total kinetic energy of 5047 kJ, with the rock blocks achieving a maximum run-out distance of up to 18 meters. These findings provide crucial insights into the dynamics of rockfall events along the highway, facilitating informed decision-making for mitigating associated risks.

.

Associate Professor, Department of Civil and Environmental Engineering, Indian Institute of Technology Patna, INDIA, akv@iitp.ac.in

Field Observation of Debris Flow: Malaysia Case Study

Nur Aishah Zarime [1], Rohayu Che Omar [2] Badariah Solemon [3] and W. A. Wahab [4]

ABS T RA CT

Landslides in hilly and mountainous areas in Malaysia have led to significant casualties and extensive economic losses[1]. Landslides are caused by disturbances in the natural stability of a slope. Debris flows are fast-moving landslides that happen under various conditions. They usually take place during heavy rainfall, typically starting on slopes or mountains. Debris flows can reach speeds over 35 mph and transport big objects like rocks, trees, and vehicles. This study aims to identify the movement types of landslides and determine the potential failures that occurred in a reserved area in Malaysia. Engineering geological mapping was carried out on-site to identify potential geohazards and other relevant aspects that might pose after debris flow occurred in the study area. On-site joint and dip readings were also used to identify potential failures through kinematic analysis. The outcome from kinematic analysis was used to assist in readjustment for RocPlane and Swedge Software. The results of this study reveal the presence of two types of landslides in the study area: translational landslide and rotational landslide (**Table 1** and **Fig. 1**). The occurrence of debris flow and landslides in the study area can be attributed to weak and poor materials, soil erosion, high groundwater levels, and, in some areas, geological discontinuity. Kinematic analysis further indicates the identification of two potential failure types: planar and wedge failures as shown in **Fig. 2**. The orientation of planar failures is noted as 62°/217°, while wedge failures occur in the directions of 30°/009°, 31°/066°, and 48°/335°. The slope face orientation is recorded as 88°/198°. In conclusion, this study successfully identified the various movement types of landslides. The utilization of identified discontinuity sets proved to detect potential failure, providing valuable insights for understanding landslide risks in the studied area.

Table 1. Findings on landslide mapping.

Hazard ID	Type Of Movement	Length (m)	Width (m)	Depth (m)	Apparent Cause	Material Type
DF1	Debris Flow	168.7	65.5	12.96	Poor/weak Material Erosion	Soil with small boulders
LSA	Rotational Landslide	47.38	12.2	3.67	Poor/weak Material	Soil with small boulders
LSB	Rotational Landslide	32.27	15.4	7	Poor/weak Material	Soil
LSC	Rotational Landslide	65.44	33.26	8.5	Erosion	Soil
LSD	Translational Landslide	71.73	18.65	6.4	Poor/weak Material	Soil
LSE	Translational Landslide	48.3	8.5	8.7	Poor/weak Material	Soil

Fig. 1. Rotational landslide with huge soil and small boulder accumulation at the toe slope.

[1] Postdoctoral Researcher, Universiti Tenaga Nasional (UNITEN), Kajang, MALAYSIA, aishahz@uniten.edu.my
[2] Associate Professor, Universiti Tenaga Nasional (UNITEN), Kajang, MALAYSIA, rohayu@uniten.edu.my
[2] Associate Professor, Universiti Tenaga Nasional (UNITEN), Kajang, MALAYSIA, badariah@uniten.edu.my
[4] Postdoctoral Researcher, Universiti Tenaga Nasional (UNITEN), Kajang, MALAYSIA, warishah.wahab@uniten.edu.my

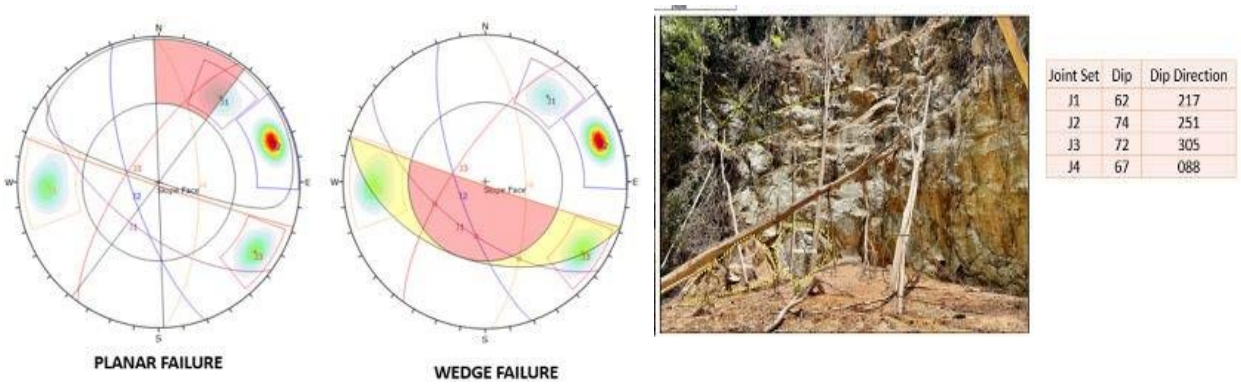


Fig. 2. Kinematic analysis and joint sets for the impacted landslide area.

References

Jamaludin, S. and Hussein, A.N., 2006: Landslide hazard and risk assessment: The Malaysian experience. IAEG 2006, **455**: 1-10.

A Case Study and Analysis of Ground Subsidence and Sliding of Road Section in Hilly Region

Arvind Kumar Jha [1], Ambikesh Dwivedi [2], Hani Singh [3] and Trilok Nath Singh [4]

ABSTRACT

The hilly terrain roads constructed in the weak rock and soil suffer due to frequent sliding of the downstream profile. Every year, hundreds of casualties and significant infrastructural damage are reported worldwide due to road slope failure. Rainfall is considered as the prime cause of the slope failures. The rainfall results in a reduction of apparent cohesion and effective stress, which ultimately reduces the shear strength of the soil. Many methods have been developed to stabilize the soil and rock slopes. The construction of retaining walls and soil grouting are viable options to stabilize the road slope. The National Highway (NH)-51 is a hilly terrain road that connects Tura and Dalu, two major cities of Meghalaya state in India. The road was opened for traffic in 2019, and since then, several stretches of the road sections have suffered damage due to sliding and sinking of the downstream ground. The present study analyzed the original road section and the proposed two-lane road section between chainage 116+400 to 116+500 for stability using Slide2 and RS2 software. A total of 8 loading conditions were assumed to simulate the effect of rainfall, earthquake, and traffic. The analysis revealed that neither the constructed road nor the proposed road sections were stable. Further, to make the proposed road section stable, retaining walls were designed following the guidelines of IS 456:2000 and 1S 14458 (Part 1):1998. The performance of retaining walls with natural site soil and grouted soil was analyzed numerically using Slide2 software. It was found that the retaining walls with natural site soil could not make the road profile stable in the combined loading conditions. In contrast, the same retaining walls with grouted soil were able to make the road sections stable against all the assumed loading conditions.

[1] Assistant Professor, Department of Civil and Environmental Engineering, Indian Institute of Technology Patna, INDIA, jhaarvind@iitp.ac.in
[2] Post Graduate Student, Department of Civil and Environmental Engineering, Indian Institute of Technology Patna, INDIA, ambikesh_2211ce13@iitp.ac.in
[3] Post Graduate Student, Department of Civil and Environmental Engineering, Indian Institute of Technology Patna, INDIA, hani_2211ce03@iitp.ac.in
[4] Professor, Department of Civil and Environmental Engineering, Indian Institute of Technology Patna, INDIA, director@iitp.ac.in

A Comparative Analysis of Web-based Tools for Landslide Mapping and Visualization

Badariah Solemon [1], Alshami Mohammed Zaid Ahmed [2] and Nur Aishah Zarime [3]

ABSTRACT

Effective management of landslide events requires the utilization of robust mapping and visualization tools to ensure prompt responses and a thorough understanding of the situation. This study undertakes a comparative analysis of web-based tools specifically tailored for landslide reporting, mapping, and viewing, to evaluate their functionalities, usability, and suitability across diverse stakeholder groups and operational contexts. This article aims to offer valuable considerations for users seeking specific functionalities and geographical coverage, contributing to ongoing efforts to leverage the capabilities of web-based technologies in the realm of landslide management in addressing this critical geological hazard. The research encompasses a comprehensive literature review and hands-on evaluations of selected platforms designed to meet the needs of landslide management. Key dimensions under scrutiny include data input mechanisms, spatial analysis features, visualization capabilities, user interfaces, accessibility, and customization options. Four publicly available web-based tools underwent examination in this study: the NASA Landslide Viewer (**Fig. 1**), the Global Landslide Detector developed by the Qatar Computing Research Institute (**Fig. 2**), the Western North Carolina (WNC) Landslide Hazard Data Viewer offered by the North Carolina Geological Survey (**Fig. 3**), and the Landslide Susceptibility Map Viewer provided by the Geological Survey Ireland (**Fig. 4**). Each platform enables users to visualize landslide occurrences, access pertinent datasets, and scrutinize specific details about each landslide event. A concise comparison table (**Table 1**) outlines the key features, emphasizing disparities between the platforms. Notably, the Global Landslide Detector distinguishes itself by leveraging real-time Twitter data, akin to the NASA Landslide Viewer, for monitoring landslides on a global scale. In contrast, the WNC Landslide Hazard Data Viewer focuses specifically on North Carolina, United States, while the Landslide Susceptibility Map Viewer prioritizes comprehensive mapping within Ireland. Of all the platforms, only the Landslide Susceptibility Map Viewer actively encourages users to contribute by submitting landslide reports, thereby providing real-time observations that enhance the dataset.

Table 1. Comparison of System Features.

Features	NASA Landslide Viewer	Global Landslide Detector	WNC Landslide Hazard Data Viewer	Landslide Susceptibility Map Viewer
Real time updates	No	Yes	No	Yes
Map layers	COOLR points/polygons, external catalog, LHASA dataset, miscellaneous, infrastructure	OpenStreetMap base map	Countries, landslide points, landslide outlines, landslide deposits, landslide susceptibility, Watauga Country ZEPRSI	Landslide events, susceptibility classification, quaternary sediments, bedrock geology 500k
Dataset download	Yes	No	Yes	Yes
View relevant publications	Yes	Yes	No	No
Generate PDF	No	No	Yes	Yes
Report new landslide	No	No	No	Yes

Fig. 1. NASA Landslide Viewer

Fig. 2. Global Landslide Detector

Fig. 3. Landslide Hazard Data Viewer

Fig. 4. Landslide Susceptibility Map Viewer

[1] Associate Professor, Universiti Tenaga Nasional, Selangor, MALAYSIA, badariah@uniten.edu.my
[2] Undergraduate, Universiti Tenaga Nasional, Selangor, MALAYSIA, sw01081352@student.uniten.edu.my
[3] Post-doctorate, Universiti Tenaga Nasional, Selangor, MALAYSIA, aishahz@uniten.edu.my

References

Geological Survey Ireland. (n.d.), 2024: Landslide Susceptibility Map Viewer. Retrieved January 3, 2024, https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=b68cf1e4a9044a5981f950e9b9c5625c.

NASA (n.d.), 2024: Landslide Viewer - NCCS Spatial Analytics Platform. Retrieved January 3, 2024, https://maps.nccs.nasa.gov/arcgis/apps/experiencebuilder/experience/?id=29bd25e78fff45f0a6dbfd0328b4d03e.

North Carolina Geological Survey (n.d.), 2024: Western North Carolina Landslide Hazard Data Viewer. Retrieved, January 3, 2024, https://www.arcgis.com/apps/webappviewer/index.html?id=e9f79de934f24e40a71bab8db8050612/.

Qatar Computing Research Institute (n.d.), 2024: Global Landslide Detector. Retrieved January 3, 2024, https://landslide-aidr.qcri.org/service.php#home.

Development and Field Validation of a Simple Water Level Gauge for Environmental Monitoring

Yuichiro Mishima [1], Katsunari Towata [2], Siti Rizkyna Noorsaly [3] and Maya Amalia Achyadi [4]

ABSTRACT

The study focused on addressing challenges in environmental monitoring, particularly the issues of data diversity, continuity, and the cost associated with sensors. similar researches have been published in several type, technical report and journal paper, or manuscript not only in Japan but also other countries (Philip Bresnahan, et al., 2022.). However, the distance sensors used in those cases had issues with waterproofing. To overcome these challenges, a Simple Water Level Gauge (SWLG) was developed using waterproof ultrasonic sensor and inexpensive electronic components, and validated in Japan and Indonesia. Our study aimed to validate the SWLG's performance in different environmental conditions.

The sensor components, listed in **Table 1**, were selected from readily available options from domestic electronic component stores and online platforms. These included an AE-ATMEGA328-MINI (Arduino Pro Mini compatible), a waterproof ultrasonic water level gauge with a measurement range of 0.21 to 6.00m, RTC (Real Time Clock), microSD card reader/writer, thermistor, and carbon resistors. These components were assembled onto a universal board or printed circuit board, enclosed in a plastic case, and installed on bridges over rivers using clamps or nearby structures.

In Japan, validation experiments were conducted comparing the SWLG's measurements with those from a radio wave water level gauge at the Hattae River Imashige Water Level Observation Station in Saga Prefecture. Measurements were taken every 15 minutes, 500 times over 2 days, from December 19th to 21 which result are shown in **Fig. 1**. The SWLG exhibited data by similar trend to the observation station, although differences in measured values (ΔE) increased during periods of decreasing water levels. It is conceivable that since there are many measurements per cycle, requiring approximately 250 seconds to complete one measurement, the error increased due to changes in the water surface during this time.

In Indonesia, the effectiveness of the SWLG under high temperature was verified in agricultural irrigation channels in South Kalimantan. Measurements were taken 5 times of measurement in every 10 minutes for 6 days, but observations ceased for approximately 12 hours twice during the period. The battery capacity was 2200mAh, and the average current consumption per hour was 7.28mAh. Calculating the expected number of days of measurement based on the average current consumption divided by the battery capacity yields approximately 12.6 days. The battery exhausted after 6 days which is shorter than expected period possibly due to the high daytime temperatures reaching 36 degrees Celsius which affects the lithium-ion battery's capacity.

Despite these challenges, the study demonstrated that the SWLG prototype enabled continuous water level measurements. However, it emphasized the importance of selecting appropriate power sources considering environmental factors such as temperature. Further improvements and considerations in sensor design and power management are necessary for reliable long-term monitoring in various environmental conditions.

[1] Lecturer, Saga University, Saga, JAPAN, sk9822@cc.saga-u.ac.jp
[2] Master's Student, Saga University, JAPAN, 23731009@edu.cc.saga-u.ac.jp
[3] PhD Student, Saga University, JAPAN, 23807291@edu.cc.saga-u.ac.jp
[4] Associate Professor, Lambung Mangkuret Unviersity, INDONESIA, mayafajeri@gmail.com

Table 1. List of items installed into SWLG (Price on March 2024).

Name of module	Price (JPY)
AE-ATMEGA328-MINI (Arduino Pro Mini compatible)	950
Water proof Ultrasonic Sensor (SEN 2080, DFRobot, 0.21-5.00m)	4,017
Real Time Clock module (RTC-8564NB)	500
DC/DC Converter kit type 5V (AE-XC9306-5V0)	350
Carbon resistance (1/4 W, 10kΩ)	1
NTC Thermistor (103AT-11)	200
MicroSD Reader/Writer (KKHMF)	698
MicroSDHC card (16GB)	550
Universal Board (47mm x 47mm x 1.2mm)	210
Plastic case (W:110mm x D:140mm x H:46mm)	1,098

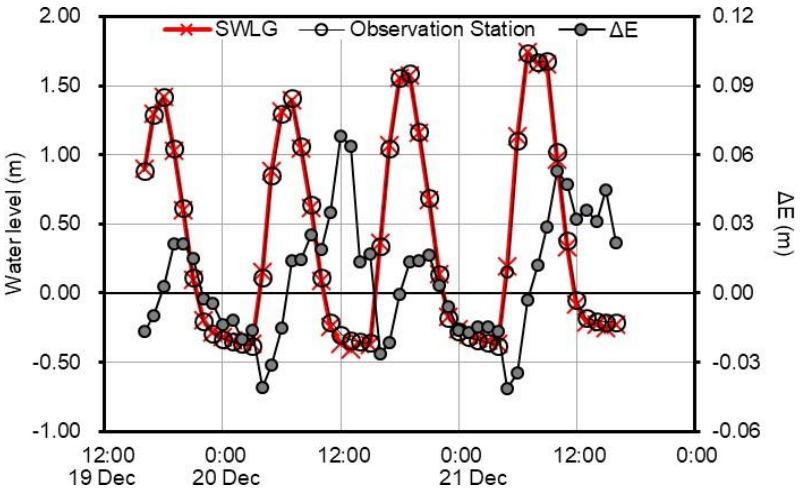


Fig. 1. Time change of Water level measured by Observation station and SWLG, with ΔE on the right vertical axis. The horizontal axis represents dates.

References

Bresnahan, P., Briggs, E., Davis, B., Rodriguez, A.R., Edwards, L., Peach, C., Renner, N., Helling, H. and Merrifield, M., 2022: A Low-Cost, DIY Ultrasonic Water Level Sensor for Education, Citizen Science, and Research, https://doi.org/10.5670/oceanog.2023.101.

General Lectures

Relationship Between the Distribution of Soil Properties and the Quality of Improved Columns Based on the Soil Structure in Saga Lowland

Kimihiro Mitsuse [1], Hirohumi Usui [2] and Takenori Hino [3]

ABSTRACT

The slurry-type deep mixing method (DMM) is extensively utilized in Saga Prefecture, Japan, as a primary measure to address soft ground issues in the Saga Lowland. This method relies on cement binders, which are water-reactive, allowing for adjustments during construction based on the water-cement (W/C) ratio. However, instances of incomplete solidification of improved columns have raised concerns, highlighting challenges in achieving effective mixing and blending between local cohesive soil and cementitious slurry. In this study, we aim to reinterpret ground investigation results obtained along the Ariake Sea coastal road (Saga Fukutomi Road) by the end of February 2024, focusing on consistency limits and compaction characteristics from a soil structure perspective. We analyzed the regional and depth distributions of these parameters. Additionally, based on the field unconfined compressive strength (quf), utilizing construction management records of the deep mixing method on the same road, we quantify the variability observed in strength development characteristics. By comparing these findings with the ground investigation results, we elucidate the influence of cohesive soil structures on the difficulty of mixing and blending in the cement slurry. Our study contributes to a better understanding of the challenges associated with the slurry-type deep mixing method and provides practical guidance for engineers in selecting W/C ratio, implementations time, DMM machine's setting, for improving construction practices in soft ground environments.

References

MOHA (Ministry of Home Affairs), DRRM Act, 2017.

Hanzawa, H., Fukaya, T., and Suzuki, S., 1990: Evaluation of engineering properties for an ariake clay. Soils and Foundations, **30**(*4*): 11-24.

Kamon, M., and Asakawa, M., 1988: Soil Mechanics (I) - Classification and Physicochemical Properties of Soil. New System of Civil Engineering (ed. by JSCE), Gihoudo Publisher, 87-97.

Kuroki, K., 2003: Practice of GIS education at Fukuoka University of Education - In the absence of GIS -. General Center for Educational Practice, Faculty of Education, Fukuoka University of Education, **11**: 15-21.

Kawazoe, R., Usui, H., Hino, T., and SOME, D. D., 2022: Strength Development Characteristics of Improved Soil by Difference of Water Cement Ratio and Agitation Time in Hasuike Clay. Proceedings of 2021 JSCE Western Branch Meeting, CD-ROM, Section III, 345-346.

Miura, T., and Hino, T., 2018: Damage of Ariake Sea Coastal Road (Saga Fukudomi Road), Ashikari Minami IC. Soft Ground Research Association, No.**15**: 83-102.

Shimoyama, S., Matsumoto, N., Yumura, H., Takehara, K., Iwao, Y., Miura, T., and Tono, I., 1994: System IV of the Ariake Sea North Coastal Lowland. Kyushu Univ. RIKEN Journal (Earth & Planetary), **18**(*2*): 103-129.

Tashiro, M., Inagaki, M., Nakano, M., Noda, T., and Asaoka, A., 2010: Effects of water contents on compression curves in remolded samples. Japanese Geotechnical Journal, **5**(*1*): 81-87.

[1] Master Student, Saga University, Saga, JAPAN, 23737001@edu.cc.saga-u.ac.jp
[2] Joint Researcher, Saga University, Saga, JAPAN, usui-h@tnx.co.jp
[3] Professor, Saga University, JAPAN, hinoilt@cc.saga-u.ac.jp

Elucidation of the Existence Form Offline/Cement–Based Binder in Slurry

Izumi Nagano[1], Yuichiro Mishima[2], Ryota Nakao[3] and Takenori Hino[4]

ABSTRACT

This study focuses on the issue of poor mixing and binder's solidification used in the deep mixing method application in Japan. As an initial step towards resolving this problem, the study experimentally confirms the chemical existence form of cementitious solidifiers in the slurry and discusses their mixing behavior with soil. Normal Portland Cement (NPC) and Cement Based Agent (CBA) were utilized in this research. Additionally, calcium oxide (CaO) was used as a reference for the reaction of calcium substances, while NaCl and $CaCl_2$ served as references for dissolution. The slurry was prepared by mixing binders and distilled water, then shaken using a shaker for a specific set of shaking time. After shaking, the slurry was filtered and analyzed to measure pH, EC, calcium, and sodium ion concentrations.

Figure 1 illustrates the pH changes over time. Under conditions which binders were used, the pH remained stable between 12.7 and 12.9 due to the over saturation of $Ca(OH)_2$. This indicates that the dissolution of $Ca(OH)_2$ reached equilibrium state.

Figure 2 shows the time changes in EC. Chloride dissolved rapidly, resulting in a high EC. On the other hand, under conditions which binders (NPC. CBA, CaO) were mixed, the EC symmetrically became lower compared to chloride's state, because the concentration of OH^- was lower ranging from $10^{-1.1}$ to $10^{-1.3}$ mol/L.

Figure 3 shows the time changes in Ca^{2+} concentration. In the $CaCl_2$ condition, Ca^{2+} concentrations ranged from 120000 to 140000 ppm, exceeding the range described in figure 3. A white creamy precipitation was observed after 120 minutes in CaO . In CBA and NPC, Ca^{2+} concentration increased after the shaking started, reaching 4200 ppm and 3700 ppm, respectively, and then Ca^{2+}decreased after 960 minutes. At this point, low-precipitation substance was observed in CBA and NPC condition and a decreasing in Ca^{2+} concentration was observed due to the formation of hydroxides.

The key findings of this study can be summarized as follows:

(1) Calcium in the slurry exists as calcium hydroxide ($Ca(OH)_2$), which is slightly soluble. $Ca(OH)_2$ will release OH^- into the liquid once becomes unsaturated.

(2) Dissolved calcium in the slurry is less than the undissolved mass.

(3) Cement binder exists in the slurry as hydroxide and hydrated material such as calcium and silica. Due to its solid-liquid separation through centrifugation and filtration, the substance is determined to be particulate matter.

(4) When the cement binder is introduced into the ground as a slurry by the current process in DMM, and mixed with the soil, it is conceivable that the binder is mixed as particulate matter.

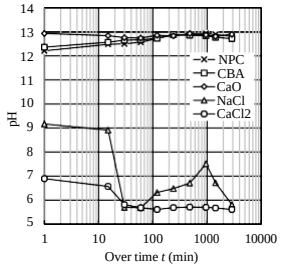


Fig. 1 Time change in pH.

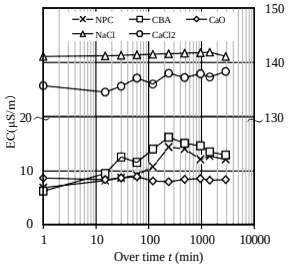


Fig. 2 Time change in EC.

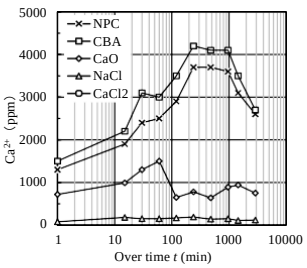


Fig. 3 Time change in Ca^{2+}.

[1] Master Student, Saga University, Japan, 24731008@edu.cc.saga-u.ac.jp
[2] Lecturer, Saga University, JAPAN, sk9822@cc.saga-u.ac.jp
[3] Master Student, Saga University, Japan, 24731007@edu.cc.saga-u.ac.jp
[4] Professor, Saga University, JAPAN, hinoilt@cc.saga-u.ac.jpS

Assessment of Rockfall of Road Cut Slope in Proximate of Lengpui Airport, Mizoram, India

Amit Jaiswal [1] , Sahil Sardana [2] , Amit Kumar Verma [3] and Trilok Nath Singh [4]

ABSTRACT

In the north-eastern part of India, rockfall is a major natural hazard that occurs frequently. It involves large boulders falling from cliffs quickly and with considerable velocities and energies, endangering human safety as well as automobiles and transportation systems. An extensive rockfall incident occurred in April 2017 along highway NH-44A near Lengpui Airport, obstructing traffic for whole one day. Fortunately, the event occurred during nighttime, minimizing the risk of casualties. Notably, this highway serves as the sole link between Aizawl city and the airport, amplifying its critical importance for regional transportation. Given the region's susceptibility to rockfall occurrences, conducting a thorough assessment of rockfall hazards along this highway is imperative. The present study undertakes such an assessment at three specific locations utilizing the Rockfall Hazard Rating System (RHRS). Pre-failure analysis reveals that slopes with the highest RHRS scores, notably 639, exhibit heightened susceptibility to rockfall events. Subsequently, these vulnerable slopes experienced rockfall activity. Furthermore, the investigation delves into the characterization of rockfall-prone zones, specifically unstable blocks, to ascertain parameters such as run-out distance, bounce height, and the kinetic energies of falling rock masses. Numerical analysis reveals a maximum total kinetic energy of 5047 kJ, coupled with a maximum run-out distance of 18 meters. These findings offer valuable insights into the potential magnitude and spatial extent of rockfall events in the study area.

[1] Department of Civil and Environmental Engineering, Indian Institute of Technology Patna, INDIA, amit_2321ce19@iitp.ac.in
[2] Department Mining Engineering, Indian Institute of Technology (Indian School of Mines), Jharkhand, INDIA, amit_2321ce19@iitp.ac.in
[3] Department of Civil and Environmental Engineering, Indian Institute of Technology Patna, INDIA, akv@iitp.ac.in
[4] Department of Civil and Environmental Engineering, Indian Institute of Technology Patna, INDIA, director@iitp.ac.in

Alashakhan is a Medieval Monument of Saryarka Architecture

R. Chekayeva [1], A. Bokachyova [2], M.Chekayev [3], A. Mukyshev [4], M. Khudoyarova [5], M. Batyrova [6], D.Baimuldina [7] and R. Bokachyov [8]

ABS T RA CT

The article is devoted to the consideration of the traditional monument of funerary and religious architecture of Saryarka. One of the remarkable medieval religious buildings is Alashakhan. Funeral and religious buildings are part of the traditional Kazakh culture and history.

Objective and the of the Study:

The purpose of this article is to provide the most complete representation of the monument as an object of material culture. Also, the purpose of the work is to identify and show the place of the studied monuments in the culture of the Kazakh people, the historical, architectural, construction, art historical significance, which is undeniable. The research presented in this article allows us to determine the place of these architectural structures in the classification system of similar monuments. The image of the Republic of Kazakhstan, which has become an independent state, is not least shaped by its historical features, unique cultural specifics and the publication of exclusively representative monuments of folk architecture in this regard is very relevant and promising not only scientifically, but also in historical, cultural, and political terms. The subject of the study is medieval monuments of memorial architecture (mausoleums).

The relatively late study of architectural monuments of the Kazakh people is explained by the stereotypical perception of nomadic culture, taking into account and emphasizing the weak degree of study of memorial monuments, we intend to fill this gap if possible. The mausoleum of Alashakhan is located on the right bank of the Karakengir River, 2 km southwest of the village of Malshybai, Ulytau district, Karaganda region. The mausoleum of Alashakhan is a single–chamber portal-domed structure built of high-strength red burnt brick, measuring 28x28x5.5 cm; 32x32x6.5 cm. The dimensions of the monument according to the external configuration are 9.73 x 11.91 m. and the square according to the internal layout is 6.31 x 6.33 m. (**Fig. 1**).

The specific feature of the structure of the building is the transition from a square plan to an octagon made by means of corner niches, the base of which begins at ground level. The transition from the octahedron to the hexahedron and further to the dome circle is carried out using stalactites in the corners of the octagon. Architect T. K. Basenov considers a somewhat unusual design technique "the presence of internal corner niches running through – from the very bottom to the base of the dome drum. In fact, the corner niches are formed as a result of laying protrusions under the heels of the corner arches, starting from the floor of the mausoleum". The mausoleum building has a shallow foundation of burnt bricks, which looks like a mausoleum wall "sunk" into the soil. Practically, the foundation of the structure is the solid (crushed stone, stone, sand) soil of the hill on which the mausoleum is built. The mausoleum building has a shallow foundation of burnt bricks, which looks like a mausoleum wall "sunk" into the soil. Practically, the foundation of the structure is the solid (crushed stone, stone, sand) soil of the hill on which the mausoleum is built. The composition of the main facade of the building consists of a very powerful peshtak portal with a large and deep niche in the center, blocked by a semicircular arch, the archivolts of which are supported by two three-quarter columns mounted on the edge of a

[1] Academic Professor, Department of Architecture, L.N. Gumilyov Eurasian National University, KAZAKHSTAN, rahima.chekaeva@mail.ru
[2] Architect, Department of Architecture, L.N. Gumilyov Eurasian National University KAZAKHSTAN, aibike.turankyzy@gmail.com
[3] Associate Professor, Department of Architecture, L.N. Gumilyov Eurasian National University KAZAKHSTAN, rahima.chekaeva@mail.ru
[4] Architect, Teacher, Pavlodar Technical University, KAZAKHSTAN, rahima.chekaeva@mail.ru
[5] Associate Professor, Samarkand State University of Architecture and Civil Engineering, KAZAKHSTAN, xudoyarova@yahoo.com
[6] Architect, Department of Architecture, L.N. Gumilyov Eurasian National University, KAZAKHSTAN, batyrova.m@bk.ru
[7] Architect, Department of Architecture, L.N. Gumilyov Eurasian National University, KAZAKHSTAN, baymuldina.dinara@gmail.com
[8] Leading Architect, AEL Trust" LLP, KAZAKHSTAN, oman_bokachyov@mail.ru

brick basement. (**Fig. 2**). The columns are made of brick with a common masonry of pylons, on the gantry of which horizontal seams are applied, dividing the column into a number of low prisms with relief. The bases of the columns consist of four hemispheres, of which the two middle ones form a complete ball, clamped by two others, with rotated planes in different directions and serving as supports for the sphere ("bullseye") and the column.

The planes of the side and back walls of the monument, above the plinth, were ornamented with figured masonry of light and dark burnt bricks in the form of "diamonds" and "triangles", which formed a picturesque pattern and created a play of light and shadow, giving an openwork masonry. (**Fig. 3**). The planes of the side walls of the peshtak are decorated with curly brickwork in the form of a "Christmas tree", with an upward arrow, which gave the peshtak lightness and upward orientation. The area around the dome drum was fenced with a parapet. The expansion of the dome is accepted by low round and lower, ten-sided drums. The creative search of architects in the X-early XI centuries led to a new architectural concept – a portal-dome composition, the main facade receives further spatial and artistic development. In the 11th century, the decoration of buildings led to careful bricklaying. (**Fig. 4**).

Conclusions:

Today, experts date the mausoleum of Alashakhan in the range from the 10th to the 15th century. The level of the authors of the few works was affected not only by the lack of systematic research, but also by the dominant Soviet ideology, which a priori claimed that the true Kazakh history began in 1917, and there was no building culture at all.

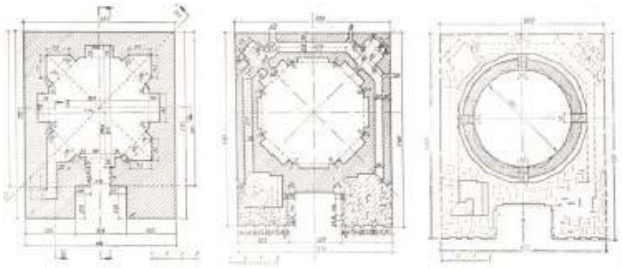


Fig. 1. The plan is at ± 0.00; ± 3.50 and the dome plan).

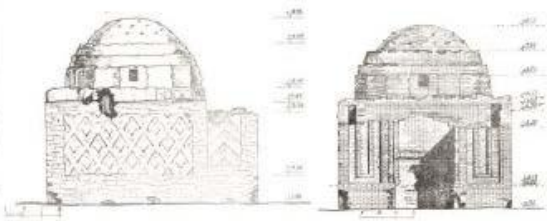


Fig. 2. Main facade and side façade.

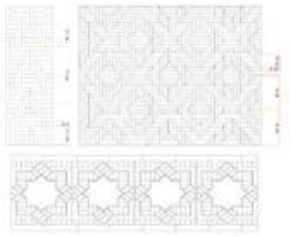


Fig. 3. Geometry and fragments of bricklaying).

Fig. 4. Bricklaying of the Mausoleum of Alashakhan.

References

Basenov, T.K, 1947: Architectural monuments in the SAM district // ed. Academy of Sciences of the Kazakh SSR. Alma-Ata, 1947, pp. 13.

Gerasimov, G.G., 1957: Architectural monuments of the Kara-Kengir river valley in Central Kazakhstan // ed. Academy of Sciences of the Kazakh SSR. Alma-Ata, 1957, pp. 24.

Castanier, I.A., 1910: Antiquities of the Kyrgyz steppe and the Orenburg region. Orenburg.

Castanier, I. A., 1911: Tombstone structures of the Kyrgyz steppes. Orenburg.

Margulan, A.H., 1947: Architectural monuments in the valley of the Kengir river (From the 1946 expedition report) // Bulletin of the Academy of Sciences of the Kazakh SSR,. **11**: 63-64.

Margulan, A.H., 1949: Architectural monuments of the district of the Republic of Tatarstan. Kengir and Sary-Su // Brief communications of the IIMK, **28**:44-47.

Nurkabayev, M.S., 1973: Report on the work of the Central Kazakhstan expedition of the Ministry of Culture of the Kazakh SSR // Archive of the scientific research department of the RSE "Kazrestavratsiya", **294**: 9-10.

Sembin, M.K., 1975: Report on the work of the Central Kazakhstan expedition of the Ministry of Culture of the Kazakh SSR in 1975 // Archive of the scientific research department of the RSE "Kazrestavratsiya", **293**: pp. 21.

Cattle Urine as a Substitute for Industrial Urea for Microbially Induced Calcite Precipitation (MICP) Treatment of Ganga River Sand

Abhishek Tarun [1] and Arvind Kumar Jha [2]

ABSTRACT

MICP is an eco-friendly and natural process that is used for biomineralization and ground improvement. The versatile application of this process for bio-calcification and bio-clogging has piqued the interest of many researchers in the past few decades. This treatment process utilizes bacteria that can produce the urease enzyme. This enzyme is responsible for urea hydrolysis which upon the addition of a calcium source formulates the calcite crystal formation and precipitation. The use of industrial urea for the MICP treatment process has a high carbon footprint and defeats the purpose of the environment-friendly treatment method. This study is mainly focused on studying the applicability of an alternative source of urea in the form of cattle urine. The use of cattle urine is beneficial as it is also helpful in animal waste disposal and sustainable resource substitution. MICP treatments were performed over Ganga River sand after the addition of Bacillus sphaericus, which is a urease-producing bacteria. The results were promising as a significant amount of calcium carbonate crystals were observed after a treatment of 12 hours. Microanalysis using FESEM, XRD, and FTIR revealed the formation of calcium carbonate crystals in the soil matrix after the MICP treatment. Calcite precipitation of around 1.27g was found for the Bacillus sphaericus supplemented sand column. The formation of calcium carbonate in the soil matrix led to a significant reduction of 36% in permeability for the treated sand column that was augmented with the ureolytic bacteria compared to the sand column without the required bacteria. The results revealed a promising and cost-effective alternative to urea substitution source for the MICP treatment process. This substitution is also good for the environment by the elimination of environmental pollution by animal waste and a sustainable urea source alternative.

Keywords: Animal waste mitigation, Calcite precipitation, MICP treatment, Sustainable urea substitution, Urine as a urea source.

[1] Research Scholar, Department of Civil and Environmental Engineering, Indian Institute of Technology Patna, INDIA, abhishek_2021ce04@iitp.ac.in
[2] Assistant Professor, Department of Civil and Environmental Engineering, Indian Institute of Technology Patna, INDIA, jhaarvind@iitp.ac.in

Experimental Study on the Shear Strength of Clay under Freeze-Thaw Cycle

Chenyu Zhu

ABSTRACT

In order to explore the solution to the problem of uneven settlement of seasonal permafrost and structural failure. In this paper, the effects of freeze-thaw cycles (N) and freezing rate (η) on the shear strength of the soil were analyzed by using the control variable method. The test results show that the shear strength of clay will decrease with the increase of the number of cycles (N), the first 7 cycles change greatly, after 1 cycle, the strain softening phenomenon of the soil occurs, after 3 cycles, the shear strength begins to decrease, and gradually approaches the equilibrium strength after 7 cycles, and basically returns to an average value at 20 cycles. The freezing rate (η) has a significant effect on the shear strength, with a slower freezing rate (η) leading to a lower shear strength, and a faster freezing rate (η) leading to a higher shear strength. It is concluded that in engineering practice, it is best to construct the basic elements and undergo at least one complete freeze-thaw cycle before applying the load, to improve reliability and safety and reduce maintenance costs.

Keywords：Clay; Freeze-Thaw Cycles; Pilot Studies; Shear Strength; Freeze-Thaw Rate

Student, Shantou University., CHINA, shensl@stu.edu.cn

Piloting of Wave Resilient Wrap Faced Embankment in Bangladesh

Ripon Hore [1] , Mosharaf Al Alim [2] , Md. Saiful Islam [3] , Abdul Siddik Hossain [4] , Md. Mozammel Haque [5] and Mehedi Ahmed Ansary [6]

ABS T RA CT

In this paper, a case study is presented for a wrap face embankment. This type of embankment is found to be more efficient than a traditional embankment in case of stability, dynamic wave action under flooding. In the deltaic region, where soft soil exists below an embankment, it may suffer relatively more damage. Under this situation, a wrap facing embankment may be a relatively better solution. The example presented here is based on a real-life wrap faced embankment on a soft soil area located at Nowagoan Alga Hati village under Mohanganj upazila, Netrokona, Bangladesh. This study also discusses the application of soil improvement for soft soils via jet grouting in some parts of the site. Jet grouting has improved soil stability and soil settling after being applied to the soil. Soil strength before and after jet grouting were 0.005 MPa and 0.94 MPa respectively. The soil gains 186.8 times the strength of soil before applying jet grouting which was very impressive. Jet grouting also improved the settlement of soil to a great extent. The areas without soil improvement by jet grouting showed more settlement than the areas with jet grouting. After flooding, settlement of wrap face embankment without jet grouting area was found to be 112 mm. On the other hand, settlement of wrap face (after flooding) in the jet grouting area was only 19mm. This research output is significant for design and implement of the future flood resilient embankment in the Deltaic region.

[1] Geotechnical Lab Manager, APS Engineering and Testing, USA, riponhore@gmail.com
[2] Assistant Engineer (SupRB) LGED, BANGLADESH
[3] Infrastructure Management Specialist, Infrastructure Management Specialist Haor Infrastructure & Livelihood Improvement Project, LGED, BANGLADESH
[4] Head of Geotech Engineering, Smart Development Engineering (SDE) Limited, BANGLADESH
[5] Project Director, Haor Infrastructure & Livelihood Improvement Project, LGED, BANGLADESH
[6] Professor, Department. of Civil Engineering, BUET, BANGLADESH

Temperature Effect on Preconsolidation Pressure: An Experimental Study on Fine Soil from Hungary

Hamed Hoseinimighani [1] and Janos Szendefy [2]

ABS T RA CT

Several engineering applications exist in which soils undergo temperature variations over time scales that can vary and last from seconds to centuries. Temperature variations can influence the engineering properties and mechanical behavior of soils, and consequently the performance of such engineering applications. An important ahavect in fine-grained soils has always been the volumetric behavior and consolidation parameters. The understanding of the response of such materials to thermal loads has warranted important scientific investigations over the past fifty years to ensure safety of geotechnical applications dealing with temperature change. In this context, this paper is devoted to the experimental investigation of the effect of temperature on the preconsolidation pressure and a temperature-controlled oedometer cell is developed in-house for this purpose. In this system, an electrical ring heater is placed around the conventional oedometer cell, which accommodates the sample and temperature of specimen is controlled during test by help of thermal controller unit. Oedometer tests were conducted on fine-grained soil samples from Budapest, Hungary at 25, 50, and 80 °C. The results indicated that preconsolidation pressure decreases with an increase in temperature. it also observed that reduction in preconsolidation pressure is different for different type of soils, and it can be linked to plasticity of fine-grained soils. Reduction in preconsolidation pressure and yield stress with increase in temperature is generally referred as thermal softening. The effect of temperature on chemical inter-particle interactions between fine soils as wells properties of double layer could play important role. Understanding of true mechanism behind thermally induced reduction in preconsolidation pressure is crucial to ensure safety of engineering applications dealing with temperature variation especially in fine soils.

[1] PhD candidate, Budapest University of Technology and Economics, Budapest, HUNGARY, hoseinimighani.hamed@emk.bme.hu
[2] Associate Professor, Budapest University of Technology and Economics, Budapest, HUNGARY, szendefy.janos@emk.bme.hu

Mucky Soil Identification Framework during Shield Tunnelling Based on YOLO Model

Wei-Wei Zhao [1,2], Shui-Long Shen [1] and Annan Zhou [2]

ABSTRACT

During shield tunneling, judgement of geological characteristics and soil-rock type ahead tunnel face in time is a key step to adjust construction parameters. Generally, field shield operational engineers observe the mucky soil type and content from belt conveyer to determine the operation of shield, which should stop the shield and are both time and cost effective. This paper proposed a deep learning framework to identify mucky soil from monitoring video mounted on strut of belt conveyer. The framework includes four steps: i) image acquisition, ii) enhanced you-only-look-once (YOLO) modelling, ii) model performance evaluation, iv) soil identification based on optimal analysis. YOLO is a deep image detection algorithm, and we proposed an enhanced YOLO via integrating two strategies: data augmentation and imbalance learning. Enhanced YOLO model can increase the speed of image identification. A case study of shield tunnelling in soil-rock mixed strata of Guangzhou-Foshan intercity railway line was conducted to verify the proposed framework. The results show that the enhanced YOLO achieves an overall classification performance on par with the highly optimized Alex Net and Google Net. Moreover, ISIF offers detection of muck soil content, which is much more effective than manual observation.

Keywords: Mucky soil identification, Data augmentation, Imbalanced learning, Shield tunnelling.

[1] MOE Key Laboratory of Intelligent Manufacturing Technology, Department of Civil Engineering and Smart Cities, College of Engineering, Shantou University, Shantou, CHINA, shensl@stu.edu.cn
[2] Discipline of Civil and Infrastructure Engineering, School of Engineering, Royal Melbourne Institute of Technology (RMIT), Victoria, AUSTRALIA

Assessing Flood Hazards and Building Vulnerability: A Case Study of Tumba Sector, Huye District/Rwanda

Henri Theogene Mugabonejo

ABS T RA CT

Floods represent a significant natural hazard, with profound socioeconomic repercussions, causing billions of dollars in damage annually (Englhardt et al., 2019). This study introduces an enhanced methodology for localized and small-scale flood damage and building risk assessments, employing the Analytic Hierarchy Process-Spatial Multi-Criteria Analysis (AHP-SMCA) framework to delineate flood exposure and vulnerability. Flood-inducing factors, including Digital Elevation Model (DEM), slope, rainfall, and Normalized Difference Vegetation Index (NDVI), were identified from literature and evaluated using AHP and pairwise comparison techniques.

Our study revealed distinct levels of flood vulnerability among buildings, categorized into medium, high, very high, and lower risk levels (**Fig. 1**). Of the 5,100 surveyed houses, 2295 were classified as medium - risk, while 570 and 208 were exposed to high and very high flood risks, respectively. Consequently, 60% of buildings fall into the very high, high, and medium risk categories, contrasting with the 40% at low flood risk (**Table 1**). The study emphasizes the significance of localized assessments in informing decision-making processes, particularly in flood insurance coverage. Identification of at-risk houses and quantification of flood hazards at a small scale facilitate targeted mitigation strategies and tailored insurance policies. Our research enriches the discourse on flood risk management and disaster resilience, underlining the importance of proactive measures in alleviating the adverse impacts of natural disasters. The findings offer crucial insights for policymakers, urban planners, and disaster management authorities, enabling informed decision-making and fostering sustainable development practices in flood-prone areas like the Tumba sector and Huye District.

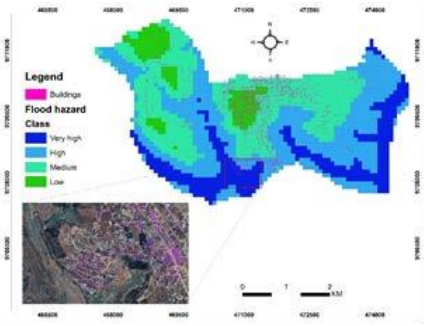


Fig. 1. Flood hazard and building vulnerability map.

Table 1. Flood risk and number of buildings exposed.

Flood Risk class	Area (Km2)	Number of Building exposed	Building exposed in percentage (%)
Very High	3.947	208	4
High	4.636	570	11
Medium	5.281	2295	45
Lower	3.576	2027	40

References

Englhardt, J., De Moel, H., Huyck, C.K., De Ruiter, M.C., Aerts, J.C.J.H. and Ward, P. J, 2019: Enhancement of large-scale flood risk assessments using building-material-based vulnerability curves for an object-based approach in urban and rural areas. Natural Hazards and Earth System Sciences, **19**(*8*): 1703–1722, https://doi.org/10.5194/nhess-19-1703-2019.

Lead Research, NARD Consult Ltd., Kigali, RWANDA, ht.mugabonejo@gmail.com

A Review of Particle Size Distribution for Improved Soil Composition Characterization in Geotechnical Engineering

Derrick Mirindi [1] and Frederic Mirindi [2]

ABSTRACT

In the face of escalating environmental concerns, understanding the impact of varied soil compositions on geotechnical properties is crucial for addressing challenges in construction engineering and geo-disaster mitigation. This review delves into the lat asset methodologies and technological advancements in soil composition analysis, with a special focus on particle size distribution—a key determinant of soil behavior and its implications for construction outcomes. The research sets out to clarify the influence of soil particle size distribution on the mechanical stability of soils, which is important for forecasting and averting geo-disasters. By merging state-of-the-art particle analysis techniques with conventional methods, the study introduces a novel perspective on soil classification and its practical applications in geotechnical engineering. The investigation uncovers that the proportion of fines and the spectrum of particle sizes substantially influence critical soil properties such as shear strength, compressibility, and hydraulic conductivity. These attributes are essential for the design and construction of geotechnical structures, particularly in regions at risk of natural disasters. The study emphasizes the importance of including a comprehensive range of particle sizes for accurate soil characterization. The principal outcomes indicate that incorporating extensive particle size distribution data into geotechnical design can markedly improve the resilience and sustainability of construction practices. This strategy not only bolsters the accuracy of soil behavior predictions but also facilitates the optimization of material selection and construction methods, thereby reducing the probability of structural failures associated with geo-disasters. Therefore, this review champions the integration of advanced soil composition analysis techniques into geotechnical engineering processes. The adoption of these cutting-edge practices is poised to transform the industry by providing engineers with the necessary tools to construct more robust and long-lasting infrastructure in an era of environmental change.

Keywords: Soil Composition, Particle Size Distribution, Geotechnical Engineering, Construction Engineering, Geo-Disasters, Soil Characterization.

[1] PhD student, Morgan State University, Baltimore, USA, derrick.mirindi@morgan.edu
[2] PhD student, University of Manitoba, Manitoba, CANADA, mirindif@myumanitoba.ca

Lidar and Photogrammetry Survey for Preparation of DEM, DSM, Contour, Ortho Photo and Tree Counting for 220 KV Transmission Line Project in Dukuchhap-Lapsiphedi Area

Bishal Dev [1], Habendra Pradad Dev [2], Krishna Kumar Dev [3] and Saksham Dhakal [4]

ABSTRACT

This paper presents a comprehensive overview of the Lidar and photogrammetric surveying conducted for mapping a powerline corridor in the challenging topography of western Nepal (**Fig. 1**). The project involved meticulous flight planning, data acquisition, and extensive post-processing methodologies to ensure the generation of accurate and high-resolution geospatial data (**Fig. 2**).

The acquisition phase utilized an AS350B3 helicopter equipped with a Riegl LMS-Q780 long-range airborne laser scanner, a medium-format Hasselblad H5Dc 100 M-pixel metric survey camera, and an IGI system Aero Control II Inertial Measurement Unit (IMU) along with Novotel OEM GPS L1/L2 Airborne GPS. The flight planning considered undulating terrain, and the data acquisition aimed to meet specifications such as a minimum Lidar point density of 20 points per m², 15% swath overlap, and horizontal and vertical accuracy (RMSE) of 10 cm and 25 cm, respectively (**Table 1**). Post-processing involved data conversion, filtering, point cloud classification, and the generation of Digital Surface Models (DSM) and bare earth Digital Terrain Models (DTM) as shown in **Table 2**. Quality control procedures were implemented at each step, ensuring the accuracy and reliability of the output. The integration of orthophotos was facilitated by terraphoto software, and the resulting products included deliverables such as raw and classified Lidar data, DEM, DSM, contours, orthophotos, and a topographical base map (**Figs. 3, 4** and **5**).

The paper highlights the challenges faced in Lidar surveying in a complex terrain and outlines the steps taken to mitigate issues, including manual classification to enhance classification results. The deliverables, adhering to specific formats and naming conventions, were handed over on external hard disks.

In conclusion, the Lidar and photogrammetric surveying successfully achieved its objectives, providing crucial geospatial data for powerline corridor mapping. The interdisciplinary nature of surveying, incorporating advanced technologies, precise methodologies, and attention to detail, underscores the importance of such projects in enhancing our understanding of complex terrains and supporting diverse applications.

Table 1. Key Parameters of LiDAR Survey.

Parameters	Values
LiDAR Scan Density	20 points/m^2
Swath Overlap	15%
Geographic Coverage	18.127 km^2
DSM/DTM Data Resolution	25 cm
Topographic Base Map	1:1000 Scale
Ground Control Point	12
Ortho Photo	10 cm
Contour	1 m
Survey Period	5th-19th June 2023

Table 2. Software.

Processing	Software
Pre-Processing	RiPROCESS
Post Processing, DEM	Terrasolid
Ortho Photo	Terrasolid, Pix4D Mapper
DSM, Contour	ArcGIS

[1] Director, Rajdevi Engineering Consultant, P. Ltd., Kathmandu, NEPAL thebishaldev@gmail.com
[2] CEO, Rajdevi Engineering Consultant, P. Ltd., Kathmandu, NEPAL, devhabendra@gmail.com
[3] LiDAR Expert, Rajdevi Engineering Consultant, P. Ltd., Kathmandu, NEPAL, me.kisna@gmail.com
[4] GIS Expert, Rajdevi Engineering Consultant, P. Ltd., Kathmandu, NEPAL, saksham.dhakal1@gmail.com

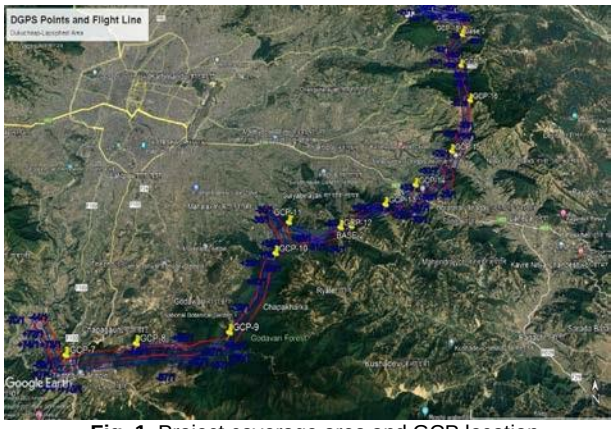


Fig. 1. Project coverage area and GCP location.

Fig. 2. Flight Line along the coverage area.

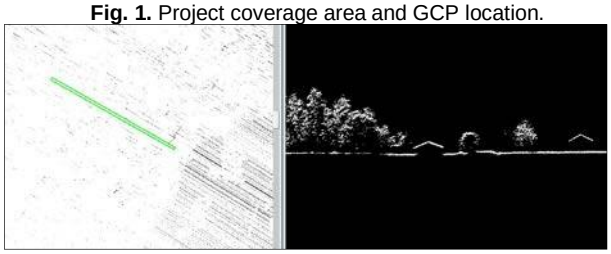


Fig. 3. Raw point cloud in greyscale.

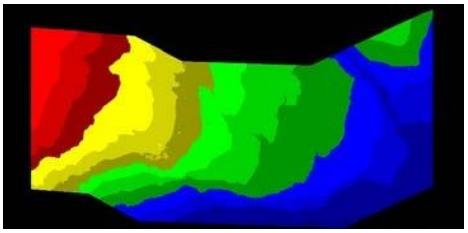


Fig. 4. Raw point cloud in colour intensity.

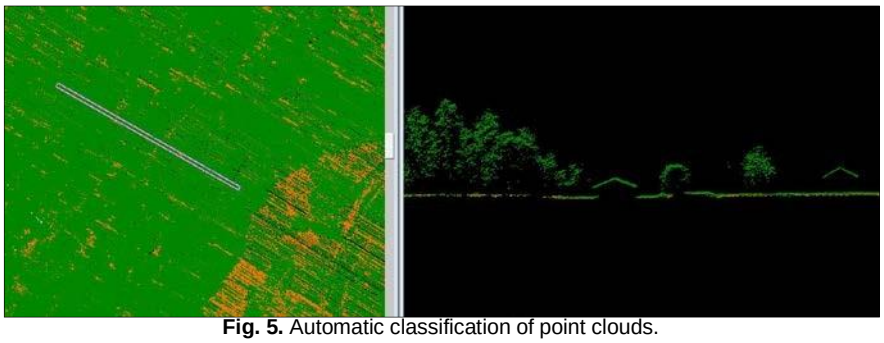


Fig. 5. Automatic classification of point clouds.

Landslide Risk Assessment on Rwanda's Road Infrastructure: A Case Study of Nyamyumba Sector, Rubavu District

Fidele Munyaneza

ABS T RA CT

Landslides, which are common in Rwanda and most of East Africa, are severe natural disasters that kill people and cause significant property damage (IFRC, 2023).

This study explores the Nyamyumba sector within Rwanda's Rubavu District, a region recognized for landslides. To evaluate landslide susceptibility, a Spatial Multi-Criteria Assessment model integrating eight key causal factors is employed, composed of the Digital Elevation Model, slope, distance to roads, lithology, rainfall patterns, the Normalized Vegetation Index (NDVI), population density, and land use. The weighting of these elements was done through the Analytic Hierarchy Process (AHP), followed by parameter ranking and spatial overlay to deliver a susceptibility map. This map is then overlaid on the present road infrastructure to determine segments prone to landslide risks. The outcomes highlight different levels of landslide susceptibility within the Nyamyumba sector (**Fig. 1** and **Table 1**). Low and very low-risk class regions cover 31402 km^2, constituting approximately 24.8% of the whole area and covering 706 km of the national roads. Further, regions classified as having a medium landslide hazard class encompass 7.62526 km^2, representing about 35.7% of the full area and covering 964 km of the national roads. High and very high landslide hazard class areas cover 52694 km^2, accounting for approximately 39.7% of the entire area and impacting 7.014 km of the national roads. Those findings underscore the necessity for targeted mitigation efforts and strategic resource allocation to protect road infrastructure and mitigate the destructive consequences of landslides in the Nyamyumba area and comparable regions across Rwanda.

The main objective of the study is to offer actionable insights to the Rwanda Roads Maintenance Fund, presenting decision-makers with localized expertise on roads prone to landslide hazards. Such insights empower effective and useful resource allocation closer to landslide risk preparedness and mitigation efforts, contributing to sustainable development and catastrophe hazard reduction in landslide-prone areas.

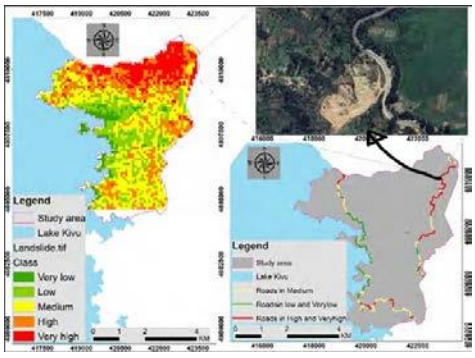


Fig. 1. Map showing landslide classes and road segments exposed to different classes.

Table 1. Table showing landslide hazard class and road segments exposed.

Hazard class	hazard Area (km^2)	Exposed Road segments (KM)	Type of Road
Low and very low	5.31402	4.706	National Road
Medium	7.62526	5.964	National Road
High and Very High	8.52694	7.014	National Road

References

IFRC, 2023: Operational Update, Rwanda - Floods and Landslides, UNHCR, December 1-12.

Civil Engineer, Petrocom Ltd, Kigali, RWANDA, mufidele92@gmail.com

Activated Carbon-Bacillus Subtlis Matrix for the Removal of Pharmaceutical Diclofenac: A Batch and Column Experiment

Chhaya [1], Trishikhi Raychoudhury [2] and Ramakrishna Bag [3]

ABS T RA CT

The Diclofenac (DCF) is a group of nonsteroidal anti-inflammatory drugs commonly used as analgesics. DCF has attracted immense attention given its hydrophilic and low biodegradability nature that makes them stable in an aquatic environment leading to immense ecological damage. Activated carbons (ACs) have emerged as promising adsorbents for removing several micropollutants. The advantage of ACs is it is environmentally friendly, has a high specific surface area, and are cost-effective. Furthermore, a granular form of ACs could also be used as a supporting material for microbes. One of the main concerns of using ACs is it will not be able to destroy the contaminant but will transform it from liquid to solid phase. On the other hand, bioremediation of organic compounds is a natural attenuation process, which could convert the toxic organic compounds to harmless end products. In this study, Bacillus subtilis biofilm supported onto AC (derived from coconut) was synthesized, characterized, and applied for the removal of DCF. Surface characterization was done using Field emission scanning electron microscopy (FESEM) and Fourier-transform infrared spectroscopy (FTIR). FESEM studies showed the bacteria was uniformly distributed over the surface and pores of ACs stating the length of bacteria varies from 2-4 µm. FTIR result shows the occurrence of a functional group for protein and nucleic acid over AC. Both studies show the efficient coating of bacteria on the surface and micro-pores of selected activated carbon. Further, DCF removal highly depends upon the pH of the solution, hence the batch experiments were conducted using synthesized activated carbon- Bacillus subtilis biofilm varying the pH (6, and 8) of DCF spiked water. Over 90% removal of 1 mg/L DCF was achieved in 120 min. Overall, the result obtained showed the potential application of synthesized biofilm in the removal of DCF from wastewater. Further, column experiment shows that composite can treat over 1350 ml of contaminated water. The obtained results show the potential use of synthesized composite in wastewater treatment processes.

[1] Department of Civil and Environmental Engineering, IIT Patna., INDIA, chhaya_1921ce07@iitp.ac.in
[2] Department of Civil and Infrastructure Engineering, IIT Jodhpur, INDIA
[3] Department of Civil and Environmental Engineering, IIT Patna., INDIA

The Identification of Landslide Hazard Areas Based on Human Activities with Geographic Information System in Central Aceh Regency

Ika Puji Hastuty [1], Fauziah Ahmad [2], Ahmad Periwira Mulia Tarigan [3], Roesyanto [4] and Chintya Sahara Fauziah [5]

ABS T RA CT

Indonesia, characterized by its complex geological and geographical features, is particularly susceptible to natural disaster, including landslides. Alongside the geological factors, human activities significantly contribute to this slope stability. Landslide defined as movement of a mass of soil or rock down a slope under the influence of gravitational force. In geotechnical engineering, landslide occurs when shear stress within a slope exceeds the shear strength of material. Geographic Information System (GIS)-based techniques have been developed and applied widely to mapping the landslide hazard area.

By using Peraturan Menteri PU No. 22/PRT/M/2007 as a reference [1], the overlay method GIS- based includes parameters such as cropping patterns, excavation and slope cutting, ponds, drainage, construction, population, and mitigation. Based on the analysis result showed in **Fig. 1** and **Fig. 2**, the percentage of landslide hazard zones, namely, low, moderate, and high are 69.85%, 29.89%, and 0.26% respectively. The result showed that the study area is dominated by a low level of landslide susceptibility caused by humans. For the verification, the result of the analysis was applied to study areas by comparison to satellite imagery, shown in **Fig. 3**. The verification results showed satisfactory agreement between the susceptibility map and the existing data on landslide locations.

$$NBT = 0.1\,(PT) + 0.2\,(PPL) + 0.1\,(PK) + 0.1\,(D) + 0.2\,(K) + 0.2\,(KP) + 0.1\,(UM)$$

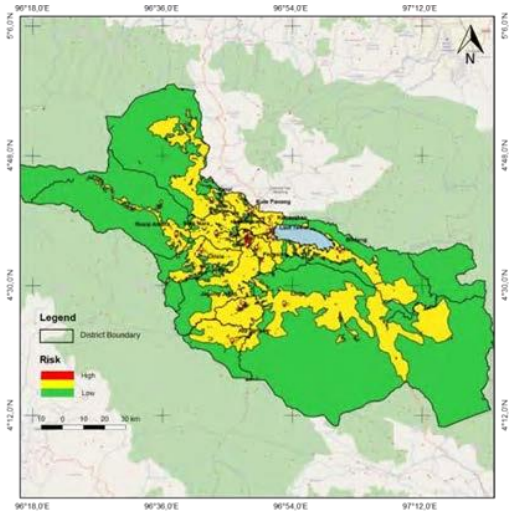


Fig. 1. The Central Aceh Regency risk map of landslide susceptibility.

[1] Lecturer, Universitas Sumatera Utara, Medan, INDONESIA, ika.hastuty@usu.ac.id
[2] Lecturer, Universiti Sains Malaysia, Nibong Tebal Penang, MALAYSIA, cefahmad@usm.my
[3] Lecturer, Universitas Sumatera Utara, Medan, INDONESIA, a.perwira@usu.ac.id
[4] Lecturer, Universitas Sumatera Utara, Medan, INDONESIA, roesyantos@yahoo.com
[5] Researcher, Universitas Sumatera Utara, Medan, INDONESIA, chintyasahara@gmail.com

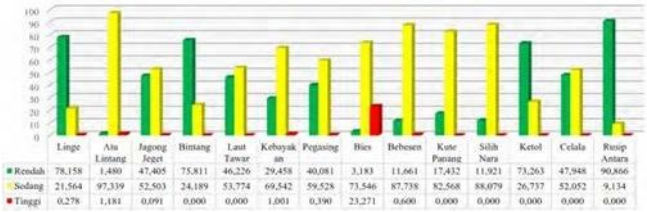


Fig. 2. Percentage of landslide susceptibility level per sub-district.

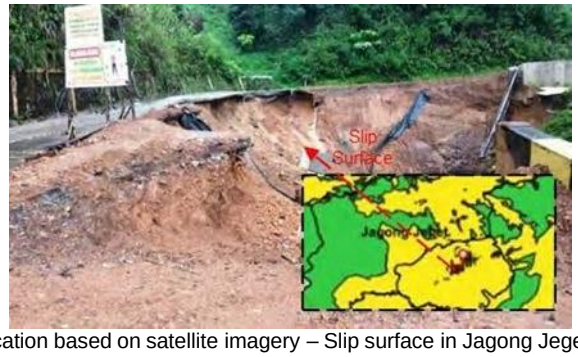


Fig. 3. Verification based on satellite imagery – Slip surface in Jagong Jeget sub-district.

References

Hidayati, Y.R., 2019: Pengaruh Kepadatan Penduduk dan Jarak Patahan terhadap Tingkat Kerawanan Longsor dengan Sistem Informasi Geografis (Studi Kasus: Kecamatan Sibolangit).

Husein, S., 2021: Mengenal Data Spasial: Data Spasial untuk Analisis Spasial, Geospasialis. Prahasta, E., 2002: Konsep-Konsep Dasar Sistem Informasi Geografis, Jurnal Informatika., Bandung.

Skempton, A. W. and Hutchinson, J., 1969: Stability of Natural Slopes and Embankment Foundations. In State-of-The-Art Report., Seventh International Conference on Soil Mechanics and Foundation Engineering., Mexico.

Exploring Adhesion Strength in Polymer Composites: Molecular Insights and Structural Applications

Amit Shrestha

ABSTRACT

Adhesion strength in polymer composites plays a pivotal role in determining their structural integrity and applicability across various industries (Kinloch, 1980). This paper delves into the molecular insights underlying adhesion phenomena within polymer composites and elucidates their implications for structural applications. Through a comprehensive review of recent advancements in materials science and polymer chemistry, we analyze the key factors influencing adhesion strength, mainly interfacial interactions. Density functional theory (DFT) and molecular dynamics (MD) simulations offer valuable insights into the mechanisms governing adhesion at the molecular level, shedding light on the role of intermolecular forces and interface design strategies (Mian, 2014).

Cyanoacrylates (CAs), renowned for their rapid curing and strong adhesion properties, have gained significant attention in composite material development (Shantha, 1989). This paper investigates the synergistic effects of CAs when incorporated into pure metal/non-metal (gold and graphite) and metal/non-metal oxide (silica and hydroxylated aluminum) composites, presenting a novel approach to enhancing material performance. Through a detailed examination of the chemical interactions between CA and the adhesive surface, we elucidate the mechanisms underlying improved adhesion strength and durability. We employ DFT and MD simulations which offer insights into the interfacial bonding within the composite system. Adhesive energy and the force analysis showed that the adhesive strength of the CA/silica and CA/hydroxylated aluminum interfaces is high compared to that of CA/gold and CA/graphite interfaces, as shown in **Fig. 1**. The hydrogen bonding between the functional groups presents on the CA and the adherend plays the pivotal role in enhancing the adhesive strength of the interface.

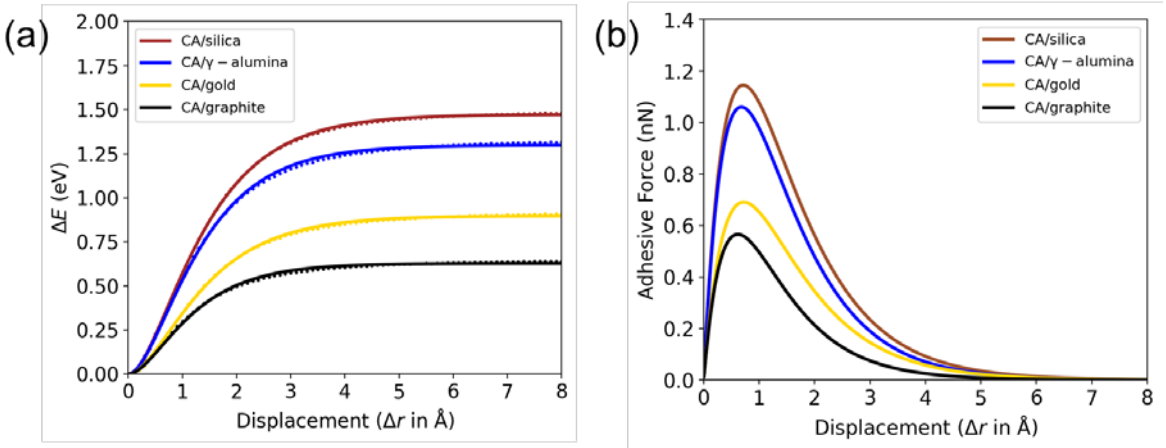


Fig. 1. (a) Energy-displacement curves for CA/silica (brown), CA/hydroxylated aluminum (green), CA/gold (yellow), and CA/graphite (black). (b) Force-displacement curves for the respective interfaces.

The potential applications of CAs-metal/non-metal oxide composites across diverse fields, including aerospace, electronics, civil engineering, are also highlighted. This study provides valuable insights into the design and optimization of CAs-based metal oxide composites, offering new avenues for advanced material development and structural applications.

Research Fellow, Kyushu University, Fukuoka, JAPAN, shresthamit009@gmail.com

References

Kinloch, A. J., 1980: The science of adhesion. Journal of Material Science, **15**, 2141-2166.

Mian, S. A., Yang, L.-M., Saha, L. C., Ahmed, E., Ajmal, M., and Ganz, E., 2014: A Fundamental Understanding of Catechol and Water Adsorption on a Hydrophilic Silica Surface: Exploring the Underwater Adhesion Mechanism of Mussels on an Atomic Scale. Langmuir, **30**, 6906-6914.

Shantha, K.L., Thennarasu, S., Krishnamurti, N. 1989: Developments and applications of cynoacrylates adhesives. Journal of Adhesive Science and Technology, **3**, 237-260.

Finite Element Analyis of Stiffened Soil Cement Column Walls Versus Conventional Retaining Structures: Stability, Construction Time and Cost Assessments

Veena Phunpeng [1,2], Menglim Hoy [2,,3], Chayanon Srijaroen [3], Suksun Horpibulsuk [4], Runglawan Rachan [5] and Arul Arulrajah [6]

ABS T RA CT

In the field of geotechnical construction, the placement of temporary retaining walls during excavation operations is seen as an essential and expensive component. The stability of soil-cement column walls in soft Bangkok clay has been the subject of several previous research that is accessible. This study is, however, focused on the link between execution time, cost, and stability of these walls, a topic that has not received much attention in previous studies. Investigating and conducting a comparative analysis of the stability, cost, and execution time of retaining walls under various construction site conditions is the main goal of this study. The study gave special attention to shallow excavation carried out in the soft Bangkok clay. The purpose of this study was to identify the best construction management techniques given the available contextual constraints. Soil-cement columns (SC), stiffened soil-cement columns (SSC), and sheet pile walls were the wall systems under investigation. The SSC was made up of an embedded steel pipe with a diameter of 0.2 meters (SSC-IRow Wall), whereas the SC had a diameter of 0.6 meters. Finite element (FE) simulation was used to evaluate the stability of the walls that were the subject of the inquiry. The first calibration of the finite element model was done by contrasting the data from field measurements with the outcomes of the simulation. The standard sheet pile wall was shown to be inferior to the SCC and SSCC Walls for a 4.5 m deep excavation requiring a factor of safety greater than 1.3. Regardless of whether it was used in limited or unconfined building sites, the two-row, seven-meter-long SC Wall proved to be more efficient in terms of both time and cost. In situations where the use of a thick SC Wall was forbidden, the SSC-IRow Wall was recommended as a substitute. Based on a careful analysis and assessment of the study results, a methodical approach to the selection and design of the SC and SSC Wall systems was suggested. The findings of this research have the potential to be applied in excavation projects that include a range of depths when dealing with Bangkok clay that is soft and similar soil types.

Keywords: Soil–cement, Ground improvement, Retaining walls, Deep excavation, Sheet pile wall.

[1] School of Mechanical Engineeing, Suranaree University of Technology, Nakhon Ratchasima 30000, THAILAND, riponhore@gmail.com
[2] Center of Excellence in Innovation for Sustainable Infrastructure Development, Suranaree University of Technology, Nakhon Ratchasima 30000, THAILAND
[3] School of Civil Engineering, Suranaree University of Technology, Nakhon Ratchasima 30000, THAILAND
[4] Thai Pile Rig, Co. Ltd, Bangok, THAILAND
[5] Academy of Science, The Royal Society of Thailand, Bangkok 10300, THAILAND
[6] S Class Engineer Co. Ltd, Nakhon Ratchasima 30000, THAILAND

Vulnerability Mapping of Landslide Hazards Based on MCDM

Qian Zheng [1], Annan Zhou [2] and Shui-Long Shen [3]

ABSTRACT

It is of importance for prevention of landslide hazards via vulnerability mapping through considering social resilience in the process of disaster mitigation. This study presents vulnerability mapping of landslide hazards based on an improved multi-criteria decision making (MCDM) risk assessment that considers social resilience. A combination of grey decision-making trial and evaluation laboratory (DEMATEL) and analytical hierarchy process (AHP) is adopted to calculate the weights. Social resilience is the ability of residents to cope with hazards in a community, which is evaluated by adaptability index layer and includes 4 factors: gender ratio, age ratio, education, and medical resource. The VIKOR method is employed to score and rank the adaptability index layer to quantify the degree of social resilience. The vulnerability mapping results are presented using the geographical information system (GIS).

A case study of historical landslides in Heyuan, China was used for validation. The results show that 17.91% area of Heyuan has the highest vulnerability, which is higher than that from traditional method (13.76%). Meanwhile, the model considering the adaptability can predict areas with high vulnerability more accurately. The study's results emphasize the need for a comprehensive assessment that includes both physical and economic-social factors in the urban vulnerability management via landslides.

Finally, management recommendations are proposed via the following three specific aspects: i) urban vulnerability management and planning, ii) inter-regional differences in socio-economic resilience, and iii) individual perceptions of landslides. These recommendations are intended to strengthen attention to the preparedness and response of developmental imbalances between communities to landslide hazards, especially in urban environments.

Keywords: Landslide Hazards, Vulnerability Mapping, Adaptability Index, DEMATEL, AHP, VIKOR.

[1] Department of Civil Engineering and Smart Cities, College of Engineering, Shantou University, Shantou, Guangdong 515063, CHINA
[2] Discipline of Civil and Infrastructure Engineering, School of Engineering, Royal Melbourne Institute of Technology (RMIT), Victoria 3001, AUSTRALIA
[3] Department of Civil Engineering and Smart Cities, College of Engineering, Shantou University, Shantou, Guangdong 515063, CHINA, shensl@stu.edu.cn

Evaluating Infrastructure and Land Use Master Plan Vulnerability to 100-Year Floodplain in Musanze City, Rwanda

Niyigena Jean Damascene

ABS T RA CT

Flash floods are a serious hazard to urban areas such as Musanze city due to high population concentrations and economic activity (Hirwa et al., 2023). Impervious surfaces and poor drainage structures exacerbate urban flooding, which is frequently caused by extreme meteorological occurrences or heavy rainstorms (Danumah et al., 2016; Herrmann & Bucksch, 2014; Jegatheesan et al., 2019). The purpose of this study is to examine the susceptibility of infrastructure and planned zoning regions to a 100-year floodplain in Musanze city, Rwanda, using a Geographic Information System (GIS). Data such as digital elevation models (DEMs), building footprints from QGIS, and Land Use Master Plan statistics were collected and arranged for analysis. A floodplain model was then developed using HEC-RAS, that included river profiles of significant water bodies to replicate floodplain extents under extreme conditions. Finally, floodplain extents were superimposed on building footprints and road networks to locate susceptible buildings and roads. Proposed zoning areas outlined in the Land Use Master Plan have also been analyzed for flood risk by masking floodplain boundaries.

The study revealed a total built-up area of 139.847 hectares, with 13.451 hectares identified as vulnerable to flooding. The proposed hazard zoning areas include 0.782877 hectares of city commercial sector (C3), 2.713 hectares of low-density residential zone (R1), and 0.207 hectares of medium-density residential - improvement sector (R2). Furthermore, major road trajectories such as the national street (NR 2), which covers 384.588 meters, and District Road 1 (DR 36), which covers 68.519 meters, are vulnerable to flooding (**Fig. 1**). The findings highlight the critical need for adaptive city strategies and resilient infrastructure development in Musanze city to reduce flood risk and ensure long-term urban growth. Authorities can prioritize flood safety measures and improve disaster preparedness efforts by identifying vulnerable locations and infrastructure. This study provides useful insights into flood risk mitigation in urban environments, emphasizing the necessity of geospatial assessment and interdisciplinary methodologies in dealing with complex environmental challenges.

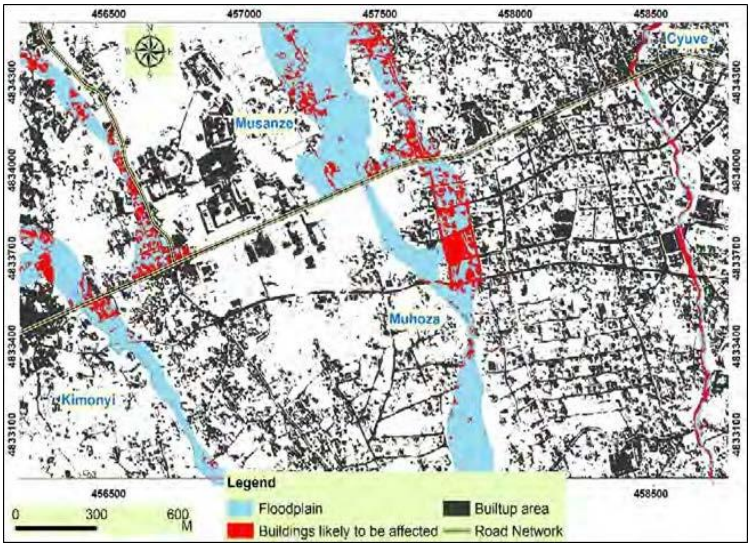


Fig. 1. Map of exposed building footprint and road networks.

Master Student, University of Rwanda, Kigali, RWANDA, jdamus.niyigena@gmail.com

References

Danumah, J. H., Odai, S. N., Saley, B. M., Szarzynski, J., Thiel, M., Kwaku, A., Kouame, F. K. and Akpa, L.Y., 2016: Flood risk assessment and mapping in Abidjan district using multi-criteria analysis (AHP) model and geoinformation techniques, (cote d'ivoire). Geoenvironmental Disasters, **3**(*1*): https://doi.org/10.1186/s40677-016-0044-y

Herrmann, H. and Bucksch, H., 2014: Urban Flood. In Dictionary Geotechnical Engineering/Wörterbuch GeoTechnik. https://doi.org/10.1007/978-3-642-41714-6_211004

Hirwa, H., Ngwijabagabo, H., Minani, M., Pierre, S. and Tuyishime, C, 2023: Geospatial Assessment of Urban Flood Susceptibility Using AHP-Based Multi-Criteria Technique: Case Study of Musanze, Rwanda. Rwanda Journal of Engineering, Science, Technology and Environment, **5**(*I*), 1–18.

Jegatheesan, V., Goonetilleke, A., Leeuwen van, J., Kandansamy, J., Warner, D., Myers, B., Bhuiyan, M., Spence, K., and Parker, G., 2019: Urban Stormwater and Flood Management: Enhancing the Live ability of Cities - Google Books. In Springer Nature Switzerland AG.

Assessing Soil-Structure Interaction Impact on Earthquake Response Spectrum through Numerical Analysis

Amir Mosallaei [1] and András Mahler [2]

ABSTRACT

The seismic response spectrum serves as a basis for earthquake design of structures. Obtaining this is generally done by simplified methods proposed by standards (i.e. considering bedrock spectrum and soil classes) or 1D site response analysis. The latter provides a reliable result for the free field condition, but it overlooks the fact that the building and its foundation may have an impact on the soil's response. The weight of the building alters the stress state and therefore the stiffness of the soil below the building, additionally the foundation elements such as piles may also have an influence on the response.

This research aims to investigate the influence of soil-structure interaction on earthquake response spectrum. To achieve this objective, a comprehensive modeling approach was adopted. A building with five floors and a basement was modeled on loose sand underlain by a deeper, denser sand layer. Three different foundation types were investigated: slab foundation, pile foundation, and rigid inclusions. Nine earthquake records, each characterized by maximum horizontal accelerations ranging from 0.08g to 0.15g, were applied to each of the three models. Subsequently, the earthquake response spectra were determined for seven different nodes within the model. Two of them (one at the base of the model and the other on the ground surface) were selected to represent free field conditions, and the other four were located close to the building and at the bedrock below the building. Based on these results the site amplification effect was evaluated for the different nodes. The aim of these analyses was to obtain how significant an effect can have the foundation on the soil amplification.

The results have shown that the building and the foundation have significant effects on soil amplification. The key conclusions are the following. Pile foundations seem to consistently decrease the amplification over the total range of periods, while in case of slab foundation and rigid inclusions the effects are less consistent and more period dependent.

[1] Ph.D. Candidate, Budapest University of Technology and Economics, Budapest, HUNGARY, mosallaei@edu.bme.hu
[2] Associate Professor, Budapest University of Technology and Economics, Budapest, HUNGARY, mahler.andras@emk.bme.hu

Thermal and Mechanical Responses of Pre-existing Cracked Rock Samples Under Uniaxial Loading: Effects of Heat Treatment and Grouting

Gaurav Kumar Mathur

ABSTRACT

Jointed rock masses generally experience high-temperature conditions across various geological infrastructures such as nuclear waste repositories, petroleum drilling sites, hydrothermal exploration areas, etc. This study examines the heat-treated rock samples with pre-existing cracks subjected to uniaxial static loading under both ungrouted and grouted conditions. Rock samples, prepared from model rock with cracks oriented at various fixed angles, have been subjected to heat treatment ranging from 30 °C to 400 °C for 24 hours. The mechanical behaviour of the samples has been evaluated through digital image correlation (DIC) analysis using MATLAB to track strain evolution. Results showed that the strength and stiffness of the samples remained consistent up to a certain temperature threshold (typically between 100 and 250 °C for model rock), beyond which they decreased significantly. Grouting improved the mechanical properties of the samples, with the degree of enhancement varying depending on the temperature. However, fracture initiation primarily occurred at the pre-existing crack tips in all samples except for those grouted at lower temperatures. Fracturing mechanisms shifted from tensile cracks to shear crack dominance with increasing temperature.

Student, Indian Institute of Technology., Patna, INDIA, gaurav_2121ce03@iitp.ac.in

Study of Deformation of Tunnel: A Case Study on Lower Modi Hydroelectric Project, Parbat, Nepal

Nabin Sapkota [1] and Suman Panthee [2]

ABSTRACT

This research was primarily focused on the development and application of empirical equations for the indirect estimation of the modulus of deformation, which is a crucial aspect for rock engineers and engineering geologists aiming to reduce project costs. The specific case study selected for this research was the squeezed tunnel section of the Lower Modi Hydroelectric Project (LMHP). This tunnel, which was constructed through fractured quartzite rocks with phyllite parting, features an overburden ranging from approximately 120 meters to 150 meters in the squeezed zone. Geologically, this area belongs to the Lower Nawakot Group of the Lesser Himalaya, encompassing the Kuncha Formation, characterized by grey and green gritty phyllite, and the Naudada Quartzite, identified by pale yellow to white fractured quartzite.

The rock mass classification in this study utilized both the Q-system and the Geological Strength Index (GSI) methods. The Q values, which represent the rock quality, ranged from 0.01 to 0.95, indicating very poor to fair rock conditions. Similarly, the GSI values ranged from 10 to 32, further characterizing the rock mass as having poor to fair geological conditions. These classifications are essential for understanding the mechanical behavior of the rock mass and for designing appropriate support systems for tunnel construction. By focusing on these empirical methods, the research aims to provide a cost-effective approach to estimating deformation modulus, which is a critical parameter for the stability and safety of underground structures.

The section exhibited a rock weathering grade of III and was characterized by a high degree of jointing, approximately 30 to 40 joints per cubic meter. Additionally, the deformability of the rock mass was assessed using the Q-system and Geological Strength Index (GSI) to determine the deformation modulus (Em). To compute the deformability, the equation proposed by Beiki et al. (2010) was utilized due to its low sensitivity to variations in rock mass classification. The deformation modulus (Em) values along the tunnel alignment were calculated based on the equations provided in **Table 1**.

The results confirm that the geotechnical properties of the intact rock strength (σ_{ci}), Unit weight (γ), intact modulus (Ei), rock mass strength (σ_{cm}) and material constant (mi) were calculated. The value of intact rock strength and rock mass strength was found to be in low range.

Rock mass classification of the tunnel section was carried out by two methods. Rock Quality Index (Q) Geological Strength Index (GSI) were used where Q ranges from 0.01 to 0.95 and GSI ranges from 10 to 32.

The deformation modulus (Em) was calculated by using different empirical methods based on the value of Q and GSI given by many researchers. From the study, it was found that some of the equations show high sensitivity and some show less sensitivity with rock mass class. Finally, it was concluded that equation given by Beiki et al. (2010) based on GSI would be the best for deformability calculation because it shows less sensitivity with rock mass class.

Table 1. Equations used to compute deformation modulus (Em) of tunnel alignment.

Grimstad and Barton (1993)	Carvalho (2004) $Em(4)=E(S)0.25, S=\exp(GSI\text{-}1009\text{-}3D$
Em (1) (Gpa)= 25logQ (Average)	Hoek and Diederichs (2006) Em (5)
Em (1) (Gpa)= 40logQ (Maxm)	$=[105(1-0.5D)1+e(75+25D-GSI11]$
Barton (1983)	Hoek and Diederichs (By using Ei) Em (6)
Em (1) (Gpa)= 10logQ (Minm)	$=E[0.02+(1\text{-}0.5D)1+e(60+15D\text{-}GSI11]$
Palmstorm and Singh (2001)	Hoek and Brown (1997) Em (7) $=(\sigma c100)0.5\times10(GSI\text{-}1040)$
Em (2) (Gpa)= 8Q0.4	Beiki.et.al. (2010) Em (8) $=[\tan(1.56+(\ln(GSI))2]0.5\times(\sigma c)13$
Barton (2002) Em (3) $=10(\times\sigma c100)1/3$	

[1] Research Staff, KMC Canada Inc., CANADA, sapkotanbn23@gmail.com
[2] Assistant Professor, Central Department of Geology, Tribhuvan University, Kathmandu, NEPAL, panthisuman@gmail.com

References

Barton, N., 1983: Application of Q system, index tests to estimate shear strength and deformability of rock masses. In: Proceedings of the international symposium on engineering geology and underground construction, Lisbon, **I**(*II*): 51-70.

Barton, N., 2002: Some new Q-value correlations to assist in site characterization and tunnel design. International Journal of Rock Mechanics and Mining Sciences, **39**: 185-216.

Bieniawski, Z.T., 1973: Engineering classification of jointed rock masses. Transactions of the South African Institution of Civil Engineers, **15**: 335-342.

Beiki, M., Bashari, A. and Majdi, A., 2010: Genetic programming approach for estimating the deformation modulus of rock mass using sensitivity analysis by neural network. International Journal of Rock Mechanics and Mining Sciences, **47**: 1091-1103.

Grimstad, E. and Barton, N.,1993: Updating the Q-system for NMT. In: Proceedings of the international symposium on sprayed concrete, Fagernes. Norway Concrete Association, Oslo: pp. 20.

Hoek, E. and Diederichs, M.S, 2006: Empirical estimation of rock mass modulus International Journal of Rock Mechanics and Mining Sciences, **43**: 203-215.

Kayabasi, A., Gokceoglu, C. and Ercanoglu M., 2003: Estimating the deformation modulus of rock mass: a comparative study. International Journal of Rock Mechanics and Mining Sciences, **40**: 55-63.

Sonmez, H., Gokceoglu, C. and Ulusay, R., 2004: Indirect determination of the modulus of deformation of rock masses based on the GSI system. International Journal of Rock Mechanics and Mining Sciences, **41**: 849-857.

Zhang, L. and Einstein, H.H., 2004: Using RQD to estimate the deformation modulus of rock masses. International Journal of Rock Mechanics and Mining Sciences, **41**: 337-341.

Use of Screw Driving Sounding (SDS) for Investigating Soft and High Variable Ground

Avidha Shah [1], Rattatam Isaroran [2] and Suttisak Soralump [3]

ABSTRACT

The Screw Driving Sounding (SDS) technique is an advanced, fully automated version of the Swedish Weight Sounding (SWS) method, developed in Japan to overcome the labor-intensive nature and reliability issues associated with SWS. Unlike the SWS, which can be significantly influenced by rod friction and heavily dependent on the examiner's expertise and site conditions, the SDS technique offers enhanced accuracy and efficiency by automating the process and including measures to calculate rod friction. This makes the SDS technique particularly advantageous as it is portable, quick, cost-effective, and requires minimal space, making it ideal for use in congested urban areas. For example, in Phra Nakhon Si Ayutthaya Province, Thailand, where sub-soil evaluation for riverbank protection was needed, the SDS technique proved to be the most suitable method due to the site's difficult access and the need for precise soil analysis.

A typical SDS machine consists of a screw point attached to a rod, which is driven into the soil by a rod rotation motor using fixed weights and torque, adhering to the same operational principle as the SWS. For enhanced performance, the standard SDS machine has been customized for this research to penetrate stiffer clay layers, using a more refined loading process with 20 steps and a maximum load of 2.3 KN. During the testing procedure, various SDS parameters are recorded at the end of each complete rotation. When a penetration depth of 0.25 meters is achieved, the screw point ascends by 0.02 meters, completes a full rotation to measure rod friction, then returns to its original position to start another penetration cycle. This systematic approach ensures a more accurate measurement of soil properties, making the SDS technique a significant improvement over the traditional SWS method.

Initially, the typical section before failure showed high shear strength (Su) according to both SDS and SPT (Standard Penetration Test) results. However, during construction, a slope failure occurred, and subsequent SDS tests revealed a drastic decrease in shear strength, which can be seen in **Fig. 3**. This critical information allowed for a new design based on the SDS test results, incorporating steel sheet piles for improved stability. **Figure 4** shows the test area after the failure. The SDS technique's continuous sampling capability was particularly beneficial, as it allowed for the identification of small soil layers that might have been missed by other testing methods. Overall, the SDS technique not only provided a reliable soil profile but also enabled effective redesign and reinforcement strategies for riverbank protection in challenging environments.

Fig. 1. A typical Screw Driving Sounding (SDS) equipment.

[1] Geotechnical Engineering Research and Development Center (GERD), Kasetsart University, THAILAND, shah.avidha@gmail.com
[2] Geotechnical Engineering Research and Development Center (GERD), Kasetsart University, THAILAND, nuk.civil@gmail.com
[3] Geotechnical Engineering Research and Development Center (GERD), Kasetsart University, THAILAND, soralump_S@yahoo.com

Fig. 1a. SDS test point location near the riverbank.

Fig. 2b. Ongoing SDS test.

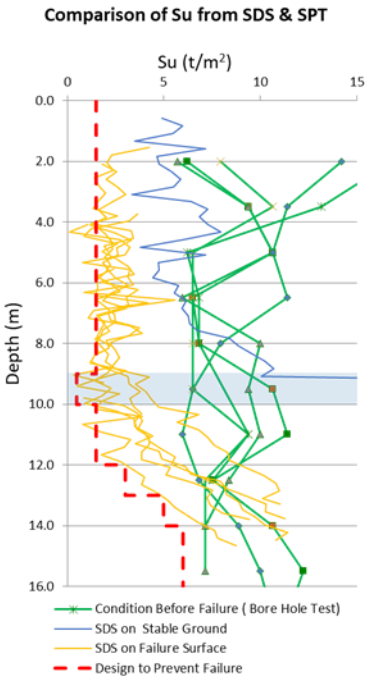


Fig. 3. Comparison of profiles of shear strength in the test area.

Fig. 4. SDS tests are performed on stable and sloped surfaces.

Numerical Simulations on Vibration Isolation Technique Using Open Trenches

Akarsh P K [1], Babloo Chaudhary [2], Ajit Kumar [3], Shabin Raj [4] and Manu K Sajan [5]

ABSTRACT

In recent times, there has been a notable surge in artificial vibration sources across various contexts, including high-speed railway lines, high-frequency machine-induced vibrations, blasting activities, intensified urban construction, and rapid advancements in railroad traffic transportation systems. The vibrations emanating from these activities have been identified as sources of annoyance for nearby residents, posing risks to adjacent aging structures, and causing interference with sensitive equipment in the vicinity. Consequently, it has become imperative to address and mitigate the adverse effects of such ground-borne vibrations. Various techniques have been developed to combat these vibrations. One effective method involves the construction of barriers strategically positioned along the path of surface wave propagation to minimize the transmission of such vibrations. This study focuses on a numerical investigation of vibration isolation using trench barriers, employing a finite element program (PLAXIS 3D) with a vertical dynamic load applied to a linear elastic half-space. The analysis utilizes the amplitude reduction factor, which compares displacement amplitudes of the ground surface with and without the barrier, to assess the effectiveness of the trench barrier. Parametric studies are conducted to explore the impact of trench geometry and the location of the vibration source on the protective performance of open trenches. The numerical analysis concludes that open trenches can effectively reduce the transmitted waves. The insights gained from this study hold practical implications for researchers and practitioners involved in designing vibration isolation barriers for various applications.

[1] Geo-disaster Prevention Lab, National Institute of Technology Karnataka, Surathkal., INDIA, akarshpk00784@gmail.com
[2] Assistant Professor, National Institute of Technology Karnataka, Surathkal., INDIA, babloo@nitk.edu.in
[3] M.Tech student, National Institute of Technology Karnataka, Surathkal., INDIA
[4] M.Tech student, National Institute of Technology Karnataka, Surathkal., INDIA
[5] Geo-disaster Prevention Lab, National Institute of Technology Karnataka, Surathkal., INDIA, manuksajan@gmail.com

Hybrid Rubble Mound Breakwater for Mitigation of Seismic Induced Effects

Akarsh P K [1], Babloo Chaudhary [2], Manu K Sajan [3] and Anil Chavan [4]

ABSTRACT

Rubble mound breakwaters conventionally constructed to protect the coastal areas from destructive sea waves. Aftermath of past earthquakes, it was evident that many of breakwaters lost their stability due to numerous reasons. Although few studies have been reported, it is not sufficient to define the failure mechanisms involved in earthquake induced damage of rubble mound (RM) breakwaters. Hence, in the present study, seismic stability of RM breakwaters is studied by conducting a series of shake table tests. The model breakwater is laid on two layers of foundation soils. The earthquake loadings are given in the form of sinusoidal wave at the base of model. Along with the traditional model, a hybrid RM breakwater model is developed at our Geo-disaster Prevention laboratory to counteract the earthquake induced effects. The hybrid model includes elements like layers of geogrids and sheet piles along with the component materials used for traditional ones. For the study, two layers of geogrid are used; one beneath the breakwater and another within the body of RM breakwater. Two sheet piles are used in the foundation soils. These hybrid reinforcing elements have been adopted to serve their purposes during earthquake loadings, which is explained in this paper. To evaluate the developed hybrid model, various criteria like reduction in settlement and displacement, generation of excess pore water pressure and deformation patterns were considered. Overall, the hybrid model is found effective in nullifying the earthquake effects on RM breakwater and its foundation.

[1] Geodisaster Prevention Lab, National Institute of Technology Karnataka, Surathkal, INDIA, akarshpk00784@gmail.com
[2] Assistant Professor, National Institute of Technology Karnataka, Surathkal, INDIA, babloo@nitk.edu.in
[3] Geodisaster Prevention Lab, National Institute of Technology Karnataka, Surathkal, INDIA, manuksajan@gmail.com
[4] Junior Research Fellow, National Institute of Technology Karnataka, Surathkal, INDIA, anilchavan414@gmail.com

Exploring Bagasse Ash as a Sustainable Subgrade Improvement for Soil Carbon Sequestration

Akashdeep Singh [1] and Rajiv Chauhan [2]

ABSTRACT

Bagasse is the fibrous residue that remains after sugarcane is crushed to release its juice. Bagasse ash is a bye-product after burning. The ecology near sugar producing facilities may suffer if this substance is disposed of improperly. The bagasse contains high silica (SiO2) content which is regarded as a pozzolanic material and has potential to be utilized in road subgrades on rural roads. Being locally available material makes it a cheaper and effective replacement for the conventional soil stabilizers. Although adding cement or lime is added to stabilize it, the process of making these materials releases carbon dioxide into the environment. This study evaluates the possible applications of sugarcane bagasse ash as a cementing agent by considering the geotechnical properties of soil that has been combined with varying proportions of 3, 6, 9, and 12% of the sugarcane bagasse ash. Soil samples were subjected to preliminary testing for identification and classification, and then consistency limit tests. The materials underwent geotechnical strength testing (compaction, unconfined compression test, California bearing ratio [CBR], and adding 3, 6, 9, and 12% sugarcane straw ash) in both stabilized and unstabilized states. The findings demonstrated that the geotechnical properties of the soil samples were enhanced by the addition of sugarcane bagasse ash. Optimum moisture content increased, CBR increased and unconfined compression strength increased in samples respectively. As a result, it was discovered that sugarcane straw ash was a useful soil stabilizer.

[1] Research Scholar, Main Campus IKGPTU, Kapurthala., Punjab, INDIA, sr.akashdeepsingh98@gmail.com
[2] Associate Professor, Main Campus IKGPTU, Kapurthala., Punjab, INDIA, dr.rajivchauhan@ptu.ac.in

Response of Offshore Wind Turbine Monopile Foundation Subjected to Monotonic Loadings: Numerical Analyses

Tanmoy Barik [1] and Babloo Chaudhary [2]

ABSTRACT

The demand for offshore wind turbines has surged in recent years due to their potential to harness strong, consistent wind resources in coastal areas. Most offshore wind farms employ fixed-foundation wind turbines in relatively shallow water. In deep waters floating wind turbine foundations have gained popularity in recent development. Among the shallow depth offshore wind turbine (OWT) foundations, monopile foundation is the most widely used foundation type. Usually, OWTs are exposed to various environmental lateral loadings like wind load, wave load etc. Therefore, the lateral responses of OWT monopiles are so significant for the design of OWT monopiles. Various experimental and numerical studies have been conducted to understand the behavior of monopile under different loading conditions but due to the complexities in offshore regions and lack of proper data, the behavior is still not completely understood. Therefore, an attempt has been made in this study to investigate the behavior of monopile foundations under the action of monotonic lateral loadings. The Finite element (FE) based software ABAQUS is used to perform numerical analysis. Elasto-plastic constitutive model is used to replicate the soil-behavior whether the monopile is modelled using elastic material.

Lateral Load Carrying Capacity (LCC) and Moment Carrying Capacity (MCC) of the monopile are calculated based on lateral pile head displacement and rotation. In addition, post analysis stress and strain contours of soil are presented to understand the effects of pile displacement (under lateral loading) on the stress-strain behavior of soil. Furthermore, parametric study has been conducted to understand the effects of soil shear strength parameters, dimensions of monopile, vertical loads, eccentricity of loading and varying soil profiles (single and multi-layer) on the lateral responses of monopiles. Result shows that dimensions of pile and eccentricity of loading have significant impacts on the LCC and MCC of the monopiles whether the effect of vertical loadings is found to be insignificant.

[1] Engineer- Geotechnical, Systra India, Kolkata, INDIA, tanmoy1barik@gmail.com
[2] Assistant Professor, National Institute of Technology Karnataka, Surathkal, INDIA, babloo@nitk.edu.in

Suitability of Ferrochrome Slag and Crusher Dust in Sub-Base Layer of Flexible Pavement and CTSB

Biswa Ranjan Jena

ABSTRACT

The construction of durable and sustainable road infrastructure necessitates the exploration of alternative materials that can supplement or replace conventional natural resources, which are becoming increasingly scarce and environmentally taxing. This study investigates the feasibility of using ferrochrome slag and crusher dust, two industrial byproducts, as materials in the subbase layer of flexible pavements. Ferrochrome slag, a busduct of the ferrochrome manufacturing process, and crusher dust, generated from the mechanical crushing of rocks, are evaluated for their physical, chemical, and mechanical properties to determine their suitability and potential environmental benefits as construction materials.

Comprehensive laboratory tests were conducted to assess the characteristics of ferrochrome slag and crusher dust, including their particle size distribution, compaction parameters, California Bearing Ratio (CBR), water absorption, and Atterberg limits. These properties were compared with those of traditional materials used in road construction to establish benchmarks. Additionally, an environmental impact assessment was carried out to evaluate the sustainability benefits of diverting these waste materials from landfills and reducing the exploitation of natural resources.

The study also involved constructing a trial section of a road using a blended mix of ferrochrome slag and crusher dust in the subbase layer and cement treated sub-base layer, followed by an evaluation of its performance through lab tests and long-term monitoring. Results indicate that the blend not only meets but, in some cases, surpasses the performance criteria of conventional subbase materials, exhibiting excellent load-bearing capacity, reduced water permeability, and enhanced durability.

Moreover, the economic analysis highlights the cost-effectiveness of using ferrochrome slag and crusher dust, considering the reduced material costs and transportation expenses. The research concludes that the incorporation of these industrial byproducts in road construction not only provides a viable technical solution but also contributes to environmental sustainability by recycling waste materials and decreasing the depletion of natural resources. The findings advocate for policy adjustments and encourage the adoption of such practices in national road construction guidelines.

Keywords: Cement Treated Sub-base (CTSB), Ferrochrome Slag, Crusher Dust, Sub-base Layer, Flexible-pavement, Waste-utilization, Industrial Byproducts Engineering Properties.

Kalinga Institute of Industrial Technology, Kalinga, INDIA, 2254002@kiit.ac.in

Numerical Analysis on Geogrid Reinforced Rubble Mound Breakwaters under Tsunami

Manu K Sajan [1], Babloo Chaudhary [2], Akarsh P K [3], Anil Chavan [4], Babita Sah [5] and Subodh Kumar [6]

ABSTRACT

The Rubble mound breakwaters play a crucial role in coastal protection, shielding communities from the relentless forces of waves and storms. However, historical tsunami events have exposed vulnerabilities in these breakwaters, leading to instances of collapse and extensive damage. The collapse of rubble mound breakwaters during the past 2004 Indian Ocean and 2011 Great East Japan tsunamis highlights the urgent need for effective countermeasures to improve their tsunami resilience. In response, this research investigates the tsunami behavior of rubble mound breakwaters. It examines potential reinforcement strategies to mitigate tsunami-induced damage. Through advanced numerical analysis using finite element modelling, geogrid reinforcements are introduced on either side of the breakwater to assess their effectiveness in reducing tsunami-induced settlements, horizontal displacements, and stability. The incorporation of geogrids emerges as a promising solution, offering several advantages over conventional breakwater models. Results demonstrate that geogrid effectively reduces the settlement of reinforced breakwater by up to 81 % under a tsunami. Moreover, geogrids demonstrate superior performance in mitigating lateral displacements and stability, highlighting their potential to enhance the tsunami resilience of the rubble mound breakwater. A parametric study was performed on the influence of the tensile strength of geogrids in improving the stability of the reinforced breakwater. This study contributes valuable insights to the field of coastal engineering and disaster resilience by providing a comprehensive analysis of geogrid reinforcements in mitigating tsunami-induced damage to rubble mound breakwaters. The findings underscore the importance of proactive measures in protecting coastal communities against the escalating threat of tsunamis, emphasizing the role of innovative engineering solutions in building resilient coastal infrastructure.

[1] Research Scholar, National Institute of Technology Karnataka, Surathkal., INDIA, manuksajan@gmail.com
[2] Assistant Professor, National Institute of Technology Karnataka, Surathkal., INDIA, babloo@nitk.edu.in
[3] Research Scholar, National Institute of Technology Karnataka, Surathkal., INDIA, akarshpk00784@gmail.com
[4] Research Scholar, National Institute of Technology Karnataka, Surathkal., INDIA, anilchavan414@gmail.com
[5] Research Scholar, National Institute of Technology Karnataka, Surathkal., INDIA, babitasah68@gmail.com
[6] Research Scholar, National Institute of Technology Karnataka, Surathkal., INDIA, subodhpl277@gmail.com

Hydrodynamic Analysis of Floating VLFS using Multi-Domain Boundary Element Method

S. Hemanth [1] and D. Karmakar [2]

ABSTRACT

The insufficiency of land and the steadily increasing world population count is responsible for exerting pressure on the coastal regions thus impelling the need to create large areas of usable land. In search of an effective, sustainable and eco-friendly technology, the concept of very large floating structures (VLFS) is coined into existence. These structures are cost effective and have a very minimal influence on the marine habitat and the ocean current flows. This concept of floating structures is extended to various real time structures like mega floating airports, bridges, offshore storage facilities, solar plants and other useful structures, attempts to design and build a working prototype of the mega floating airports and submerged floating bridges are carried out in countries like Japan and Netherlands, few of their noteworthy achievements being the Kansai international airport in Japan and the Veluwemeer Aqueduct in the Netherlands. In the deep-sea conditions, the wavelengths of the waves interacting with these very large floating structures are too short to induce a significant effect on the rigid body motions hence these VLFSs are flexible, and the study of their hydro elastic behavior is of utmost concern.

The present study emphasizes the investigation of rigid and hydro elastic very large floating structures (VLFS) on analyzing the deflections, wave forces, reflection and transmission coefficients. The comparison involves analyzing the hydrodynamic and hydro elastic characteristics of a porous non-elastic VLFS, a rigid VLFS, and hydro elastic VLFS. The analysis is performed using coupled multi-domain boundary element method (MDBEM) and finite difference method (FDM) at finite water depth. The VLFS is modelled based on the thin plate and small amplitude wave theories. The study evaluates the hydro elastic behavior in terms of structural deflection and hydrodynamic parameters by varying the structural porosity. The reflection and transmission coefficients are analyzed to show the extent of wave propagation on the leeside and seaside of the structure. The wave force coefficients obtained signify the importance of the structure's orientation for the oncoming waves. The numerical results are validated with the results available in the literature. The analysis is performed for different structural and material properties to obtain the minimal hydro elastic and hydrodynamic response and assess the optimum design criteria and suitability of the type of VLFS, thereby maintaining the stability of the structure for safer operations.

Keywords: Very Large Floating Structures (VLFS); Multi-domain Boundary Element Method (MDBEM); Hydroelasticity; Finite Difference Method (FDM); Wave Dissipation.

[1] Research Fellow, Department of Water Resources and Ocean Engineering, NITK Surathkal, INDIA, Hemanth.sanjiv@gmail.com
[2] Associate professor, Department of Water Resources and Ocean Engineering, NITK Surathkal, INDIA, dkarmakar@nitk.edu.in

Offshore Wind Turbine Foundation Subjected to Dynamic Loads: Numerical Analysis

Subodh Kumar [1], Babloo Chaudhary [2], Manu K Sajan [3], Akarsh P K [4], Babita Sah [5] and Anil Chavan [6]

ABSTRACT

Offshore wind energy has emerged as a pivotal source of renewable energy, driven by the need to address climate change and reduce reliance on fossil fuels. The behavior of offshore wind turbine foundations plays a critical role in ensuring the efficiency and durability of these structures in harsh marine environments. In this paper study has been done at how offshore wind turbine foundations work, focusing on using suction caissons. Suction caissons are important because they provide strong support for wind turbines in different ocean environments. Then, the study looks at how earthquakes affect these foundations. Earthquakes are a big challenge for offshore structures, so it's important to keep them strong and resilient. We use special computer software called PLAXIS 3D to simulate how the ground and structure interact during earthquakes. Study investigates the dynamic behavior and stability of offshore wind turbine suction caisson foundations through comprehensive parametric analysis using PLAXIS 3D software, various aspects of foundation design were examined, including caisson length, soil properties, wind loads, and seismic events. The influence of caisson length on lateral stability and settlement characteristics was studied. Results show that increasing caisson length improves lateral stability and reduces settlement, emphasizing the importance of optimizing aspect ratios for enhanced performance. Soil properties, particularly unit weight and cohesion, significantly affect foundation behavior. Denser soils offer greater resistance to compression, resulting in lower settlement and horizontal displacement. Higher cohesion enhances the foundation's resistance to lateral loads and reduces excess pore water pressure. Wind loads exerted on the structure were analyzed to understand their impact on foundation response. The study also assessed the foundation's response to seismic events, highlighting its vulnerability and the importance of seismic-resistant design measures. Foundations in seismic-prone regions may experience larger settlements during earthquakes, necessitating careful consideration of seismic loading conditions. Furthermore, the impact of varying earthquake frequencies on foundation behavior was explored. The study revealed that the foundation's response is frequency-dependent, with low-frequency seismic events causing larger vertical displacements due to prolonged ground shaking. Overall, this parametric study sheds light on the intricate interactions between offshore wind turbine foundations and their geological and environmental contexts. The findings underscore the importance of optimizing caisson length, understanding soil properties, and considering wind and seismic loading conditions in foundation design. This research contributes valuable insights that can inform future design standards and practices, ultimately enhancing the safety and efficiency of offshore wind turbine installations.

Keywords: Offshore, Foundation, Wind, Numerical, Dynamic.

[1] Research Scholar, National Institute of Technology Karnataka, Surathkal, INDIA, subodhpl277@gmail.com
[2] Assistant Professor, National Institute of Technology Karnataka, Surathkal, INDIA, babloo@nitk.edu.in
[3] Research Scholar, National Institute of Technology Karnataka, Surathkal, INDIA, manuksajan@gmail.com
[4] Research Scholar, National Institute of Technology Karnataka, Surathkal, INDIA, akarshpk00784@gmail.com
[5] Research Scholar, National Institute of Technology Karnataka, Surathkal, INDIA, babitasah68@gmail.com
[6] Research Scholar, National Institute of Technology Karnataka, Surathkal, INDIA, anilchavan414@gmail.com

Cyclic Response of Offshore Wind Turbine Foundation: Numerical Simulations

Subodh Kumar [1], Babloo Chaudhary [2] , Manu K Sajan [3], Akarsh P K [4], Babita Sah [5] and Anil Chavan [6]

ABS T RA CT

As the demand for renewable energy continues to grow, offshore wind energy has emerged as a promising source of clean power. However, the harsh marine environment poses significant challenges for the design and operation of offshore wind turbine (OWT) foundations. Understanding the cyclic response of these foundations is crucial for ensuring their structural integrity and long-term reliability. In this context, numerical simulations offer a valuable tool for investigating the complex interactions between OWT foundations and the surrounding soil under cyclic loading conditions. This study focuses on exploring the cyclic response of offshore wind turbine foundations through advanced numerical simulations. The research integrates finite element analysis (FEA) techniques with soil-structure interaction models to capture the dynamic behavior of OWT foundations subjected to cyclic loading induced by environmental factors such as waves, wind, and currents. The numerical simulations consider various design parameters, including foundation geometry, soil properties, loading characteristics, and installation methods, to comprehensively assess their influence on the cyclic performance of OWT foundations. Through systematic parametric studies and sensitivity analyses, this research aims to provide insights into the key factors affecting the cyclic response of offshore wind turbine foundations. The findings contribute to enhancing the design guidelines and optimization strategies for OWT foundations, ultimately improving the efficiency, durability, and cost-effectiveness of offshore wind energy projects. Moreover, the numerical simulations serve as a valuable platform for validating experimental results and benchmarking numerical models, thereby advancing the state-of-the-art in offshore wind energy research and engineering practice. By presenting the latest advancements in numerical modeling techniques and their application to the cyclic response of offshore wind turbine foundations, this paper offers valuable insights for researchers, engineers, and industry professionals involved in the design, analysis, and maintenance of offshore wind energy systems. Through interdisciplinary collaboration and knowledge exchange, we can address the challenges associated with offshore wind energy and accelerate the transition towards a sustainable energy future.

[1] Research Scholar, National Institute of Technology Karnataka, Surathkal, INDIA, subodhpl277@gmail.com
[2] Assistant Professor, National Institute of Technology Karnataka, Surathkal, INDIA, babloo@nitk.edu.in
[3] Research Scholar, National Institute of Technology Karnataka, Surathkal, INDIA, manuksajan@gmail.com
[4] Research Scholar, National Institute of Technology Karnataka, Surathkal, INDIA, akarshpk00784@gmail.com
[5] Research Scholar, National Institute of Technology Karnataka, Surathkal, INDIA, babitasah68@gmail.com
[6] Research Scholar, National Institute of Technology Karnataka, Surathkal, INDIA, anilchavan414@gmail.com

Engaging Public in Landslide Risk Management: Insights and Strategies for Proactive Communities

Warishah Abdul Wahab [1], Abdul Aziz Mat Isa [2], Rohayu Che Omar [3], Muhammad Farid Bin Ibrahim [4], Daud Mohamad [5], Nur' Aishah Zarime [6], Rasyikin Roslan [7], Syed Zainal Abidin Bin Syed Kamarulbahrin [8] and Nur Salina Rosli [9]

ABSTRACT

In the dynamic landscape of risk management, understanding human perceptions and responses to natural hazards is crucial. This study delves into the perspectives and actions of communities living near to the dam or slope area (shown in **Fig. 1** and **Fig. 2**) regarding landslide risks. A perception survey, encompassing constructs of feeling, knowledge, behavioral responses, environment, and overall perceptions, was administered to 124 participants. The descriptive statistics as shown in **Table 1** reveal a mean score of 3.792 for the entire dataset, signaling a heightened awareness and concern about landslide occurrences. Among the constructs, feeling stands out with a mean score of 3.730, indicating a strong emotional response to potential risks. Knowledge, with a mean score of 3.370, suggests an intermediate level of understanding among the communities involved. The behavioral construct, with the highest mean score of 4.163, underscores a proactive approach towards mitigating landslide risks. This proactive stance is further supported by the high scores in the environment construct, indicating a mindfulness of environmental factors contributing to landslide risks (mean score: 3.853).

From the overall descriptive analysis results, many respondents have good knowledge and perception of landslides. The correlation analysis shown in **Table 2** to **Table 4**, was also performed to measure the existence and strength of a linear relationship between the demographic profile and constructs, and the correlation between the constructs itself. The age and work experience positively correlate with the environment construct. The correlation between construct results reveals that feeling and environment have the strongest positive correlation ($r = 0.604$, $p = 0.000$), followed by attitude and environment ($r = 0.572$, $p = 0.000$). Age has a weaker positive correlation with feeling and environment, while knowledge has weaker positive correlations with feeling, attitude, and environment. The significant correlations suggest that there is a relationship between these variables, although the strength of the relationships varies. These findings hold significant implications for risk management strategies. It highlights the need for tailored educational programs that equip communities with the knowledge and skills to effectively manage landslide risks. Furthermore, community-based initiatives can leverage these insights to foster proactive engagement and risk mitigation.

Table 1. Descriptive Statistics for each construct on Perception Survey.

	N	Mean	Std. Deviation
Feeling	124	3.7258	.57519
Knowledge	124	3.3656	.77088
Behavioral	124	4.1633	.54245
Surrounding	124	3.8532	.65969
Overall	124	3.7917	.45810
Valid N (listwise)	124		

Table 2. Correlation between Age and independent variables.

		Correlation				
		Age	Feeling	Knowledge	Attitude	Environment
Age	Pearson Correlation	1	.136	.072	.239**	.239**
	Sig. (2 tailed)		.133	.425	.007	.008
	N	124	124	124	124	124

[1] Researcher, Universiti Tenaga Nasional, MALAYSIA, warishah.wahab@uniten.edu.my
[2] Associate Professor, Universiti Tenaga Nasional, MALAYSIA, azan@uniten.edu.my
[3] Associate Professor, Universiti Tenaga Nasional, MALAYSIA, rohayu@uniten.edu.my
[4] Lecturer, Universiti Tenaga Nasional, MALAYSIA, farid.ibrahim@uniten.edu.my
[5] Lecturer, Universiti Tenaga Nasional, MALAYSIA, daud@uniten.edu.my
[6] Researcher, Universiti Tenaga Nasional, MALAYSIA, aishahz@uniten.edu.my
[7] Lecturer, Universiti Tenaga Nasional, MALAYSIA, rasyikin@uniten.edu.my
[8] Researcher, Universiti Tenaga Nasional, MALAYSIA, szainal@uniten.edu.my
[9] Researcher, Universiti Tenaga Nasional, MALAYSIA, nursalinarosli@gmail.com

As a conclusion, further research is recommended to explore the factors influencing these perceptions as well as the stability of the slope near the residential area. The investigation can advance the comprehension of human responses to natural hazards, informing more effective risk management strategies in similar communities.

Fig. 1. GLC residential building in dam area.

Fig. 2. GLC residential building near slope.

Table 3. Correlation between work experience and independent variables.

Correlation						
		Work Experience	Feeling	Knowledge	Attitude	Environment
Work Experience	Pearson Correlation	1	.109	.098	.096	.236**
	Sig. (2-Tailed)		.226	.280	.286	.008
	N	124	124	124	124	124

Table 4. Correlation between constructs.

Correlations						
		Age	Feeling	Knowledge	Attitude	Environment
Age	Pearson Correlation	1	.136	.072	.239**	.239**
	Sig. (2-tailed)		.133	.425	.007	.008
	N	124	124	124	124	124
Feeling	Pearson Correlation	.136	1	.250**	.515**	.604**
	Sig. (2-tailed)	.133		.005	.000	.000
	N	124	124	124	124	124
Knowledge	Pearson Correlation	.072	.250**	1	.194*	.179*
	Sig. (2-tailed)	.425	.005		.031	.047
	N	124	124	124	124	124
Attitude	Pearson Correlation	.239**	.515**	.194*	1	.572**
	Sig. (2-tailed)	.007	.000	.031		.000
	N	124	124	124	124	124
Environment	Pearson Correlation	.239**	.604**	.179*	.572**	1
	Sig. (2-tailed)	.008	.000	.047	.000	
	N	124	124	124	124	124

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed).

References

Bardhan, P. and Gavious, A. 2020: Understanding Human Perceptions of Landslide Risks. A Review of Current Literature. Journal of Natural Hazards and Disaster Management, **8**(*2*): 123-135. https://doi.org/10.1234/jnhdm.2020.1234

Smith, J. L. and Brown, K. A. 2021: The Role of Emotional Response in Risk Perception and Preparedness. A Study of GLC Staff in Dam Area Quarters. Journal of Risk and Disaster Management, **10**(*3*): 345-357.https://doi.org/10.1234/jrdm.2021.345

Johnson, S. M. and Patel, R. N. 2022: Proactive Approaches to Landslide Risk Mitigation. Insights from GLC Staff. Journal of Risk and Environmental Management, **11**(*1*): 45-56. https://doi.org/10.1234/jrem.2022.45

Anderson, T. J. and Thompson, M. R. 2019: Environmental Factors Contributing to Landslide Risks. A Study of GLC Staff Perspectives. Journal of Environmental Studies, **7**(*4*): 567-579. https://doi.org/10.1234/jes.2019.567

Kaur, P. and Singh, R. 2020: Correlation Analysis of Demographic Factors and Construct Results. A Study of GLC Staff. Journal of Social Science Research, **9**(*2*): 231-245. https://doi.org/10.1234/jssr.2020.231

Patel, A. and Gupta, V. 2021: Tailored Educational Programs for Landslide Risk Management. A Study of GLC Staff Perspectives. Journal of Education and Training, **8**(*3*): 432-445. https://doi.org/10.1234/jet.2021.432

Khan, S. A. and Choudhury, A. B. 2022: Community-Based Initiatives for Landslide Risk Mitigation. Insights from GLC Staff. Journal of Community Development, **10**(*4*): 567-579. https://doi.org/10.1234/jcd.2022.567

Sharma, R. K. and Verma, A. 2019: Factors Influencing Perceptions and Responses to Landslide Risks. A Study of GLC Staff in Dam Area Quarters. Journal of Risk and Resilience, **7**(*1*): 123-135. https://doi.org/10.1234/jrr.2019.123

Gupta, S. and Choudhury, A. B. 2020: Stability of Slope Near Residential Areas. A Study of GLC Staff Perspectives. Journal of Geotechnical and Environmental Engineering, **9**(*3*): 345-357. https://doi.org/10.1234/jgee.2020.345

Patel, S. and Sharma, R. 2021: Human Responses to Natural Hazards. Insights from a Study of GLC Staff. Journal of Environmental Psychology, **10**(*2*): 45-56. https://doi.org/10.1234/jep.2021.45

Brown, A. J. and Smith, K. R. 2022: Effective Risk Management Strategies for Similar Communities. A Study of GLC Staff. Journal of Risk Management, **11**(*1*): 567-579. https://doi.org/10.1234/jrm.2022.567

Thompson, M. J. and Anderson, T. 2019: Human Perception of Landslide Risks. A Study of GLC Staff Perspectives. Journal of Disaster Studies and Management, **8**(*4*): 432-445. https://doi.org/10.1234/jdsm.2019.432

Gupta, V. and Patel, A. 2020: Community Engagement in Landslide Risk Mitigation. A Study of GLC Staff Perspectives. Journal of Community Psychology, **9**(*3*): 567-579. https://doi.org/10.1234/jcp.2020.567

Kaur, P. and Singh, R. 2021: Human Perception of Landslide Risks. A Study of GLC Staff in Dam Area Quarters. Journal of Environmental Health Sciences, **10**(*2*): 45-56. https://doi.org/10.1234/jehs.2021.45

Sharma, R. K. and Verma, A. 2022: Understanding Human Responses to Landslide Risks. A Study of GLC Staff Perspectives. Journal of Risk and Resilience, **11**(*1*): 567-579. https://doi.org/10.1234/jrr.2022.567

A Data-Driven Approach for Risk Assessment During Shield Tunnelling

Xin-Hui Zhou [1] and Shui-Long Shen [2]

ABSTRACT

Underestimation of risks during tunnelling may result in substantial economic losses and even fatal incidents. This study develops a data-driven approach for evaluating construction risk levels during tunnelling. Two computational models including the deep forest algorithm (DF) and fuzzy set pair analysis (FSPA) are fused, where the DF is employed for predicting shield operational parameters and the FSPA is utilized to evaluate the risk level based on the predicted operational parameters. Furthermore, a linear combination of the subjective and objective weights obtained from the fuzzy analytic hierarchy process and coefficient of variation method, respectively, is adopted to calculate the weights used in FSPA. The proposed method is then applied to a case study of the field tunnel project in Guangzhou, China. The analysis results indicate that the calculated risk level for the first 600 rings shows good agreement with the real engineering observations. In addition, the proposed method also predicts a relatively high risk (risk level IV) during the construction of rings 1571 to 1580. The proposed method offers a reliable and feasible tool for proactively assessing the risk levels in shield tunnelling.

Keywords: Shield Tunnel; Construction safety; Operational Parameters; Deep Forest Algorithm; Fuzzy Set Pair Analysis

[1] Shanghai Jiao Tong University, Shanghai 200240, CHINA, shensl@stu.edu.cn
[2] Shantou University, Shantou, Guangdong 515063, CHINA, shensl@stu.edu.cn

Research on Predicting Unfrozen Water Content in Seasonal Frost Regions: A Review

Xiao Dingyuan

ABSTRACT

The unfrozen water content in frozen soil exerts a significant influence on the engineering properties, heat conduction, and hydrological processes of soil. In geological engineering practices conducted in cold regions, the assessment of groundwater levels, groundwater flow dynamics, and the interaction between soil and groundwater heavily relies on accurate determination of unfrozen water content. Since the 20th century, scholars have developed a variety of models to predict the subzero content of unfrozen water in frozen soils. These models can be categorized into empirical models, physical and theoretical models, models based on soil water characteristic curves (SWCC), as well as machine learning models. This review primarily focuses on three aspects related to unfrozen water content modeling: (1) evaluating the contributions made by various models towards predicting unfrozen water content; (2) summarizing SWCCs along with physical and theoretical models alongside their associated technologies; (3) highlighting challenges encountered during advancements in this field. The objective of this article is to provide valuable insights for future research endeavors concerning unfrozen water content in frozen soil.

Keywords: Seasonal Frost Soil; Unfrozen Water Content; Prediction Model; Machine Learning.

PROGRAM AT A GLANCE

Time	June 07, 2024 (Friday)	
9:30 – 10:00	Registration	Great Hall, BF
10:00 – 10:20	Opening Ceremony	
10:20 – 10:40	Plenary Speech-1	
10:40 – 11:00	Plenary Speech-2	
11:00 – 11:10	*Discussions*	
11:10 – 11:20	*Coffee Break*	
11:20 – 11:35	Keynote Speech-1	
11:35 – 11:50	Keynote Speech-2	
11:50 – 12:05	Keynote Speech-3	
12:05-12:15	*Discussions*	
12:15 – 13:00	*Lunch Break*	
13:00 – 13:15	Keynote Speech-4	
13:15 – 13:30	Keynote Speech-5	
13:30 – 13:40	*Discussions*	
13:40 – 13:50	*Coffee Break*	
13:50 – 14:00	Invited Speech-1	
14:00 – 14:10	Invited Speech-2	
14:10 – 14:20	*Discussions*	
14:20 – 14:30	*Coffee Break*	
14:30 – 15:20	Workshop Session by IRCC	
	Special Guest Speaker-1	
	Special Guest Speaker-2	
15:20 – 15:30	*Discussions*	
15:30 – 15:45	*Coffee Break*	
15:45 – 17:53	General Presentations	
17:53 – 18:15	*Discussions*	

Time	June 08, 2024 (Saturday)	
10:00 – 10:20	Plenary Speech-3	Great Hall, BF
10:20 – 10:40	Plenary Speech-4	
10:40 – 11:00	Plenary Speech-5	
11:00 – 11:10	*Discussions*	
11:10 – 11:20	*Coffee Break*	
11:20 – 11:35	Keynote Speech-6	
11:35 – 11:50	Keynote Speech-7	
11:50 – 12:05	Keynote Speech-8	
12:05 – 12:20	Keynote Speech-9	
12:20-12:30	*Discussions*	
12:30 – 13:10	*Lunch Break*	
13:10 – 13:25	Keynote Speech-10	
13:25 – 13:40	Keynote Speech-11	
13:40 – 13:55	Keynote Speech-12	
13:55 – 14:10	Keynote Speech-13	
14:10-14:25	Keynote Speech-14	
14:25 – 14:35	*Discussions/Coffee Break*	
14:35 – 14:45	Invited Speech-3	
14:45 – 14:55	Invited Speech-4	
14:55 – 15:05	Invited Speech-5	
15:05 – 15:15	*Discussions*	
15:15 – 15:25	*Coffee Break*	
15:25 – 16:29	General Presentations	
16:29 – 16:40	*Discussions*	
16:40 – 16:45	Short Break	
16:45 – 17:10	Closing & Award Ceremony	
17:10 – 19:00	Banquet & Cultural Show	

DETAILED PROGRAM

June 07, 2024 (Friday)		
09:30-10:00	**Registration**	
10:00-10:20	**Opening Ceremony**	
	Plenary Speech-1	**Country**
10:20-10:40	Transformative Impact of Artificial Intelligence on Geotechnical Engineering and Soil Improvement Techniques ***Dr. Shahab Yasrebi, Geomaple Inc. Canada***	**Canada**
	Plenary Speech-2	
10:40-11:00	Investigations of Pile Foundations of 70 m High New Monument in Astana City ***Prof. Askar Zhussupbekov, Eurasian National University, Kazakhstan***	**Kazakhstan**
Session Chair: Prof. Trilok Nath Singh, Indian Institute of Technology Patna, India		
11:00-11:10	***Discussions***	
11:10-11:20	***Coffee Break***	
	Keynote Speech-1	
11:20-11:35	On Innovative Thinking Way in Engineering Science and its Applications ***Prof. Shui-Long Shen, Shantou University, China***	**China**
	Keynote Speech-2	
11:35-11:50	A Core System Model for Effective Crisis & Emergency Management in Crisisonomy: Analyzing the Sewol Ferry Disaster in Korea ***Prof. Jae Eun Lee, National Chungbuk University, Korea***	**Korea**
	Keynote Speech-3	
11:50-12:05	Development of Flood Protection Infrastructures in Bangkok Lowland and Ground Subsidence Area ***Prof. Suttisak Soralump, Kasetsart University, Thailand***	**Thailand**
Session Chair: Dr. Shahab Yasrebi, Geomaple Inc. Canada		
12:05-12:15	***Discussions***	
12:15-13:00	***Lunch Break***	

	Keynote Speech-4	
13:00-13:15	Enhanced Tensile Fatigue Performance of Cement Stabilized Pavement Base Using Natural Rubber Latex ***Prof. Suksun Horpibulsuk, Suranaree University of Technology, Thailand***	**Thailand**
	Keynote Speech-5	
13:15-13:30	Rockfall Prediction, Prevention, and Mitigation ***Prof. Trilok Nath Singh, Indian Institute of Technology Patna, India***	**India**
Session Chair: Prof. Shui-Long Shen, Shantou University, China		
13:30-13:40	***Discussions***	
13:40-13:50	***Coffee Break***	

	Invited Speech-1	
13:50-14:00	Numerical and Physical Modelling of Rockfall Activities in Himalayan Region of India ***Dr. Amit Kumar Verma, Indian Institute of Technology Patna, India***	**India**
	Invited Speech-2	
14:00-14:10	Field Observation of Debris Flow: Malaysia Case Study ***Dr. Nur Aishah Za and Dr. Rohayu Che Omar, Institute of Energy Infrastructure, Universiti Tenaga Nasional, Malaysia***	**Malaysia**
Session Chair: Dr. Veena Phunpeng, Suranaree University of Technology, Thailand		
14:10-14:20	***Discussions***	
14:20-14:30	***Coffee Break***	

	Workshop Session by IRCC Officer, Canada	
14:30-15:20	**Special Guest Speaker** Economic Pathways to Immigration ***Myreille Besner***	**Canada**
Session Chair: Dr. Pritam Shrestha, Humber College, Canada		
15:20-15:30	***Discussions***	
15:30-15:45	***Coffee Break***	
15:45-18:15	**General Presentations**	
15:45-15:53	Relationship between the Distribution of Soil Properties and the Quality of Improved Columns Based on the Soil Structure in Saga Lowland ***Kimihiro Mitsuse, Hirohumi Usui and Takenori Hino***	**Japan**
15:53-16:01	Elucidation of the existence form of line/cement-based binder in slurry ***Izumi Nagano, Yuichiro Mishima, Ryota Nakao and Takenori Hino***	**Japan**
16:01-16:09	Assessment of Rockfall of road cut slope in proximate of Lengpui Airport, Mizoram, India ***Amit Kumar Jaiswal, Sahil Sardana, Amit Kumar Verma and Trilok Nath Signh***	**India**
16:09-16:17	Alashakhan is a Medieval Monument of Saryarka Architecuture ***R. Chekayeva, A. Bokachyova, M. Chekayev, A. Mukyshev, M. Khudoyarova, M. Batyrova, D. Baimuldina and R. Bokachyov***	**Kazakhstan**
16:17-16:25	Cattle urine as a substitute for industrial urea for Microbially Induced Calcite Precipitation (MICP) treatment of Ganga River sand ***Abhishek Tarun and Arvind Kumar Jha***	**India**
16:25-16:33	Experimental Study on The Shear Strength of Clay under Freeze-thaw Cycle ***Chenyu Zhu***	**China**
16:33-16:41	Piloting of wave resilient Wrap Faced Embankment in Bangladesh ***Ripon Hore, Mosharof Al Alim, Md. Saiful Islam, Abdul Siddik Hossain, Md. Mozammel Haque and Mehedi Ahmed Ansary***	**USA**
16:41-16:49	Temperature Effect on Preconsolidation Pressure:An Experimental Study on Fine Soil from Hungary ***Hamed Hoseinimighani and Janos Szendefy***	**Hungary**
16:49-16:57	Mucky soil identification framework during shield tunnelling based on YOLO model ***Qi Zhou, Shui-Long Shen and Annan Zhou***	**China**

15:45-18:15	**General Presentations**	
16:57-17:05	Assessing Flood Hazards and Building Vulnerability: A Case Study of Tumba Sector, Huye District/Rwanda.	**Rwanda**
	Henri Theogene Mugabonejo	
17:05-17:13	A Review of Particle Size Distribution for Improved Soil Composition Characterization in Geotechnical Engineering	**USA**
	Derrick Mirindi and Frederic Mirindi	
17:13-17:21	Lidar and Photogrammetry Survey for Preparation of DEM, DSM, Contour, Ortho Photo and Tree Counting for 220 KV Transmission Line Project in Dukuchhap-Lapsiphedi Area	**Nepal**
	Bishal Dev, Habendra Prasad Dev, Krishna Kumar Dev and Saksham Dhakal	
17:21-17:29	Landslide Risk Assessment on Rwanda's Road Infrastructure: A Case Study of Nyamyumba Sector, Rubavu District.	**Rwanda**
	Fidele Munyaneza	
17:29-17:37	Activated carbon-Bacillus subtlis matrix for the removal of pharmaceutical diclofenac: a batch and column experiment	**India**
	Chhaya, Trishikhi Raychoudhury and Ramakrishna Bag	
17:37-17:45	The Identification of Landslide Hazard Areas Based on Human Activities with Geographic Information System in Central Aceh Regency	**Malaysia**
	Ika Puji Hastuty, Fauziah Ahmad, Ahmad Perwira Mulia Tarigan, Roesyanto and Chintya Sahara Fauziah	
17:45-17:53	Exploring Adhesion Strength in Polymer Composites: Molecular insights and Structural Applications	**Japan**
	Amit Shrestha	
Session Chair: Dr. Suman Manandhar, Global Institute for Interdisciplinary Studies, Nepal		
17:53-18:15	***Discussions***	

June 08, 2024 (Saturday)

9:30-10:00	*Coffee Refreshment*	
	Plenary Speech-3	
10:00-10:20	Road to the Top of the World: Observed and Forecasted Thermal Regime under Climate Change Scenarios ***Prof. Marolo Alfaro, University of Manitoba, Canada***	**Canada**
	Plenary Speech-4	
10:20-10:40	Vacuum-PVD Improvement: A Case Study of the Second Improvement of Soft Bangkok Clay for Third Runway Extension Project ***Prof. Dennes T. Bergado, Asian Institute of Technology, Thailand***	**Thailand**
	Plenary Speech-5	
10:40-11:00	Sustainability and its Assessment in Geotechnical Engineering ***Prof. Dipanjan Basu, University of Waterloo, Canada***	**Canada**
Session Chair: Prof. Emeritus Masayuki Hyodo, Yamaguchi University/Asahitechno Co. Ltd., Japan		
11:00-11:10	*Discussions*	
11:10-11:20	*Coffee Break*	

	Keynote Speech-6	
11:20-11:35	Climate Change Ramifications Focusing on Recent Heavy Rainfall-Induced Geo-Disasters in Kyushu Island, Japan ***Prof. Noriyuki Yasufuku, Kyushu University, Japan***	**Japan**
	Keynote Speech-7	
11:35-11:50	Application of Multi-Hazard Risk Assessment for Preparing Risk Sensitive Land Use Plan: A Case Study to Cope with Geo-Disaster for Resilient Society ***Dr. Suman Manandhar, Global Institute for Interdisciplinary Studies***	**Nepal**
	Keynote Speech-8	
11:50-12:05	Geotechnical Engineering Opportunities in Ontario ***Er. Reza Mahmoudipour, Englobe, Canada***	**Canada**
	Keynote Speech-9	
12:05-12:20	The Liquefaction-Induced Large Scale Flow Slide in Loess Deposit during the Jishishan 6.2 Earthquake and its Risk Zonation ***Prof. Lanmin Wang, Lanzhou Institute of Seismology, China Earthquake Administration, China***	**China**
Session Chair: Prof. Suksun Horpibulsuk, Suranaree University of Technology, Thailand		
12:20-12:30	*Discussions*	

12:30-13:10	*Lunch Break*	
	Keynote Speech-10	
13:10-13:25	Lowering the Groundwater Table and Promoting Consolidation of Soft Soils by Negative Pressure Loading using the Super Well Point (SWP) Method ***Prof. Masayuki Hyodo, Yamaguchi University, Japan***	**Japan**
	Keynote Speech-11	
13:25-13:40	Disaster Gerontology Perspective on Disaster Risk and Crisis for Older Adults ***Prof. Keiko Kitagawa, Saga University, Japan***	**Japan**
	Keynote Speech-12	
13:40-13:55	Sustainable Practices in Civil Engineering ***Prof. Catherine Mulligan, Concordia University, Canada***	**Canada**
	Keynote Speech-13	
13:55-14:10	Pathway to Employment for Newcomer Professionals in Canada ***Dr. Pritam Shrestha, Humber College, Canada***	**Canada**
	Keynote Speech-14	
14:10-14:25	Community Slope Risk, Awareness and its Guideline in Penang, Malaysia ***Prof. Fauziah Ahmad, Universiti Sains Malaysia***	**Malaysia**
Session Chair: Prof. Qi Zhou, Western University, Canada		
14:25-14:35	*Discussions/Coffee Break*	
	Invited Speech-3	
14:35-14:45	A Case Study and Analysis of Ground Subsidence and Sliding of Road Section in Hilly Region ***Dr. Arvind Kumar Jha, Indian Institute of Technology Patna, India***	**India**
	Invited Speech-4	
14:45-14:55	A Comparative Analysis of Web-Based Tools for Landslide Mapping and Visualization ***Dr. Badariah Binti Solemon, Institute of Enenery Infrastructure, Universiti Tenaga Nasional, Malaysia***	**Malaysia**
	Invited Speech-5	
14:55-15:05	Development and Field Validation of a Simple Water Level Gauge for Environmental Monitoring ***Dr. Yuichiro Mishima, Saga University, Japan***	**Japan**

Session Chair: Dr. Amit Kumar Verma, Indian Institute of Technology Patna, India		
15:05-15:15	***Discussions***	
15:15-15:25	***Coffee Break***	
15:25-16:40	**General Paper Presentations**	
15:25-15:33	Research on Predicting Unfrozen Water Content in Seasonal Frost Regions: A Review	**China**
	Xiao Dingyuan	
15:33-15:41	Finite Element Analyis of Stiffened Soil Cement Column Walls Versus Conventional Retaining Structures: Stability, Construction Time and Cost Assessments	**Thailand**
	Veena Phunpeng, Menglim Hoy, Chayanon Srijaroen, Suksun Horpibulsuk, Runglawan Rachan and Arul Arulrajah	
15:41-15:49	Vulnerability Mapping of Landslide Hazards Based on MCDM	**Australia**
	Qian Zheng, Annan Zhou and Shui-Long Shen	
15:49-15:57	Evaluating Infrastructure and Land Use Master Plan Vulnerability to 100-Year Floodplain in Musanze City, Rwanda	**Rwanda**
	Niyigena Jean Damascene	
15:57-16:05	Assessing Soil-Structure Interaction Impact on Earthquake Response Spectrum through Numerical Analysis	**Hungary**
	Amir Mosallaei and Andras Mahler	
16:05-16:13	Thermal and Mechanical Responses of Pre-existing Cracked Rock Samples Under Uniaxial Loading: Effects of Heat Treatment and Grouting	**India**
	Gaurav Kumar Mathur	
16:13-16:21	Study of Deformation of Tunnel Emphasis on Squeezing: A Case Study of Lower Modi Hydroelectric Project, Parbat, Napel	**Canada**
	Nabin K. Sapkota and Suman Panthee	
16:21-16:29	Use of Screw Driving Sounding (SDS) for investigating soft and high variable ground	**Thailand**
	Avidha Shah, Rattatam Isaroran and Suttisak Soralump	
Session Chair: Dr. Yuichiro Mishima, Saga University, Japan		
16:29-16:40	***Discussions***	
16:40-16:45	***Short Break***	
16:45-17:10	**Closing & Award Ceremony**	
17:10-19:00	**Banquet & Cultural Show**	

GUIDELINES TO SPEAKERS & SESSION CHAIRS

Guidelines to Speakers

a. It is suggested to prepare your presentation in both PPT and PDF formats and keep a secure copy on a USB/Pen Drive (version 3.0 or higher).

b. Please ensure that you arrive at the presentation hall/room at least 15 minutes before your session is scheduled to start. Upload your presentation materials in the assigned media and check the compatibility with the technical staff in the presentation hall. In case your PPT encounters problem, have the PDF version ready to prevent any disruptions during your presentation.

c. Presentation time for different categories of speakers is shown below.

Speech/Presentation categories and allotted time

Plenary Speech	**20 minutes**
Keynote Speech	**15 minutes**
Invited Speech	**10 minutes**
Guest Speaker	**30 minutes**
General Presenter	**8 minutes**

Guidelines to Session Chairs

a. Please confirm the presence of the speakers at least 10 minutes before the start of your session.

b. Please ensure starting time for each presentation, as mentioned in the conference program, to maintain a smooth flow without interruption. Our technical staff will be available to keep the time of each presentation.

c. Please provide ratings on the evaluation sheet to be kept on your table to recommend the Best Presentation.

d. Printed copies of the CVs of the plenary, keynote, special guest and invited speakers will be kept on your table.

e. The session chair should determine Q&A time for plenary, keynote, special guest, invited speakers and general presenters based on the time of execution.

GUIDELINES TO PARTICIPANTS BEFORE & DURING ARRIVAL TO CANADA

KMC Canada Corporate Inc. (KMC Canada) would like to warmly welcome you to the International Conference on Geo-Disaster and Construction Engineering 2024, Waterloo, Ontario, Canada. This guidebook will enable to enlighten travelers from abroad and Canada.

Transportation Guide:

For air travel, **Toronto Pearson Airport** (YYZ), situated 98 km from the University of Waterloo, offers daily non-stop flights from various cities including Vancouver, Calgary, Ottawa, and Montreal. Transportation options from the airport include taxis, rideshares, or the **UP Express** (**Photo 1**).

Alternatively, **Billy Bishop Toronto City Airport** (YTZ), located 112 km away, serves flights from cities such as Ottawa, Montreal, and Halifax. Transportation from this airport includes a complimentary shuttle bus to Union Station or a ferry to the terminal on Bathurst Street (free for pedestrians).

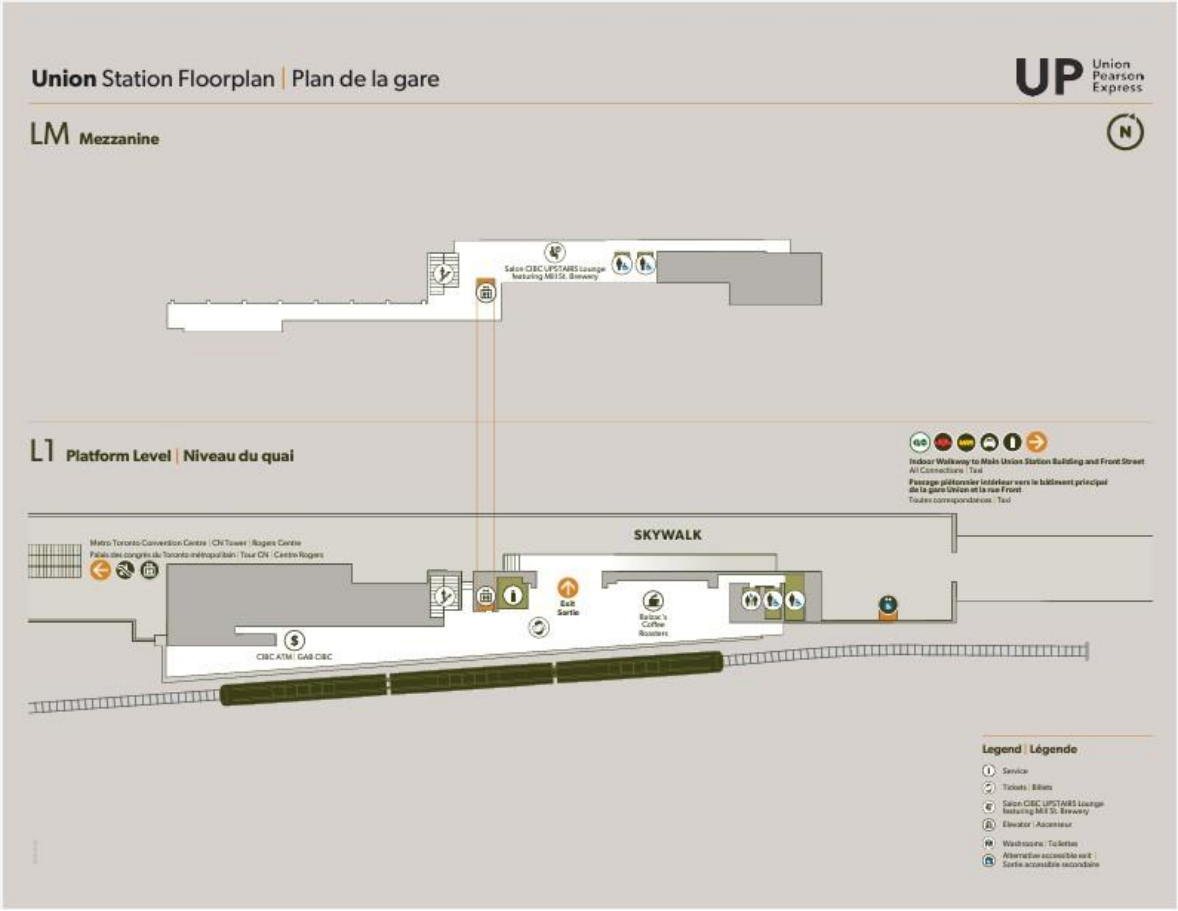


Photo 1: Union Station map (UP Express); Source: Pearson Airport Website

Arriving at the Airport:

Upon arrival at **Lester B. Pearson International Airport** **(**YYZ) in Toronto, Ontario, international passengers are required to follow specific procedures outlined by the Canada Border Services Agency (CBSA). Please visit the website for a detailed explanation of **steps to follow once off**

the plane to know the process of how **CBSA Declaration Card works**.

At Primary Inspection, CBSA officers will review essential documents such as your **Passport** and **Invitation Letter** to ensure compliance with entry requirements.

It is advisable to carry printed copies of these documents in your carry-on luggage for easy access.

If you have shipped items to Canada in advance, inform the CBSA officer and provide shipping records as necessary.

Additionally, if you are **entering Canada with more than $10,000** in cash, bank drafts, or traveler's cheques, it must be declared on the CBSA Declaration Card. For detailed instructions, refer to the Government of Canada's website.

Navigating Pearson International Airport:

a. Follow the signs to "Customs" (**Photo 2**).
b. Walk through the lobby (**Photo 3**).
c. Wait in line to speak to a border agent (**Photo 4**).
d. Pick-up your luggage at baggage claim (**Photo 5**).
e. Exit into the arrival lobby (**Photo 6**).

Photo 2: Direction for Custom

Photo 3: View of lobby

Photo 4: Waiting for border agent

Photo 5: Baggage claim zone

Photo 6: Exit and arrival zone

Sources: Google and Pearson Airport Website

Transportation Facility from Airport to Venue (University of Waterloo):

To facilitate transportation from the airport to the venue (University of Waterloo), there are various options available, including taxi and limousine services.

It's important to note that some drivers inside the terminals may not be licensed taxis or limos and may charge higher rates. To ensure fair pricing and safety, please be cautious and look for signage indicating verified transportation services throughout the airport.

Airways Transit:

Airways Transit offers door-to-door airport ground transportation services and operates from both Terminal 1 and Terminal 3 at Lester B. Pearson International Airport (YYZ).

For estimated pricing, you can visit their **private airport rate by service area webpage**. As of October 2023, the starting price per ticket from Pearson International Airport to Waterloo is CAD185 one way.

Go Transit:

GO Bus is a popular transportation choice for traveling between various cities. For more details, you can visit the **Going to the Airport with GO Transit website**. Additionally, passengers can purchase E-tickets in advance for added convenience.

If you arrive at Pearson International Airport, you can board GO Bus Route 40 from Terminal 1 to Square One Terminal. From Square One Terminal, you have the option of taking Route 25 or 25C to reach the University of Waterloo. It's worth noting that Route 25C is the express bus service. For information regarding fares, you can visit the **website** provided.

Generally, Go Transit is the more budget-friendly option. As of November 2022, the fare from Pearson International Airport to Waterloo is approximately 17.55 CAD (tax included) for a one-way trip, but this rate is subject to change. Periodically, Go Transit provides special promotions that may offer a more economical rate. For the latest information on costs, you can refer to the Go Transit website.

Taxi:

Another option for transportation to the venue is taking a taxi. **Waterloo Taxi** is one available option, and you can find information about rates on their website.

At the airport, it's important to be cautious of drivers who approach passengers inside the terminals offering transportation services. These individuals may operate unlicensed taxis and limousines, often charging higher rates than regulated services. To ensure a safe and reliable ride, look for signage throughout the airport indicating verified transportation services.

Traveler's Guide Transferring from Another Canadian City:

If you're planning to travel to the venue from another Canadian city, there are various ground transportation options available:

i. **Train Services:** You can explore train services, such as **VIA Rail**, which offers rail travel between major Canadian cities. Check their website for schedules and ticket information. **GO Transit** offers limited train service to the venue from the Greater Toronto Area (GTA).
ii. **Intercity Bus Services:** Several intercity bus companies operate routes connecting major cities in Canada. Greyhound, Megabus, and other regional carriers provide affordable bus transportation options.
FlixBus and **GO Transit** are two popular options for ground travel. It's advisable to book your ticket at least two months before your planned travel date to secure your seat. Keep in mind that most companies have luggage restrictions, so it's essential to check their policies beforehand to ensure your luggage complies with their limits.
iii. **Personal Vehicle:** If you prefer flexibility, you can drive to the venue using your personal vehicle. Ensure your vehicle is in good condition for a comfortable journey.
iv. **Ridesharing Services:** Platforms like Uber or Lyft might be available, offering a convenient and potentially cost-effective way to travel between cities.
v. **Rental Car:** Canadians drive on the right-hand side of the road. To rent a car, most rental companies in Canada require you to be at least 21 years old. If you are under 25, you may have to pay for additional insurance.

Flight Services: Depending on the distance, you may also explore domestic flights to nearby airports, followed by ground transportation to Waterloo.

Hot Offer Discount in Airfare:

The **ICGCE-2024** has negotiated the discounted fare for the participants with **Air Canada** and **WestJet**. Please use the promocode to claim the discounted fare.

Carrier	Promo Code	Book Online
Air Canada	**PYRD7Q61**	**aircanada.com**

Carrier	Promo Code	Book Online
WestJet	**3R506PL**	**www.westjet.com**

Discounted Offer: Hotel/Accommodation near the Conference:

There are several hotels/accommodations near the venue (University of Waterloo). The Hampton Inn, Kitchener, and Crowne Plaza Kitchener are the official conference hotels. ICGCE-2024 has negotiated special discounted room rates, which you can book through the link: https://icgce2024.ca/accomodations-near-waterloo/. Conference rates are only available through the link, subject to availability. Availability is limited and expected to sell out soon.

WEATHER OF WATERLOO, TORONTO

The month of June marks the official start of summer in Canada. It's an ideal time to visit and indulge in the plethora of activities the country has to offer. During this month, expect plenty of sunshine, particularly inland where temperatures can soar up to 30°C (**Photo 7**). However, be prepared for occasional rain showers. For more detailed weather forecasts, you can visit the local weather forecast website a https://weather.gc.ca/canada_e.html.

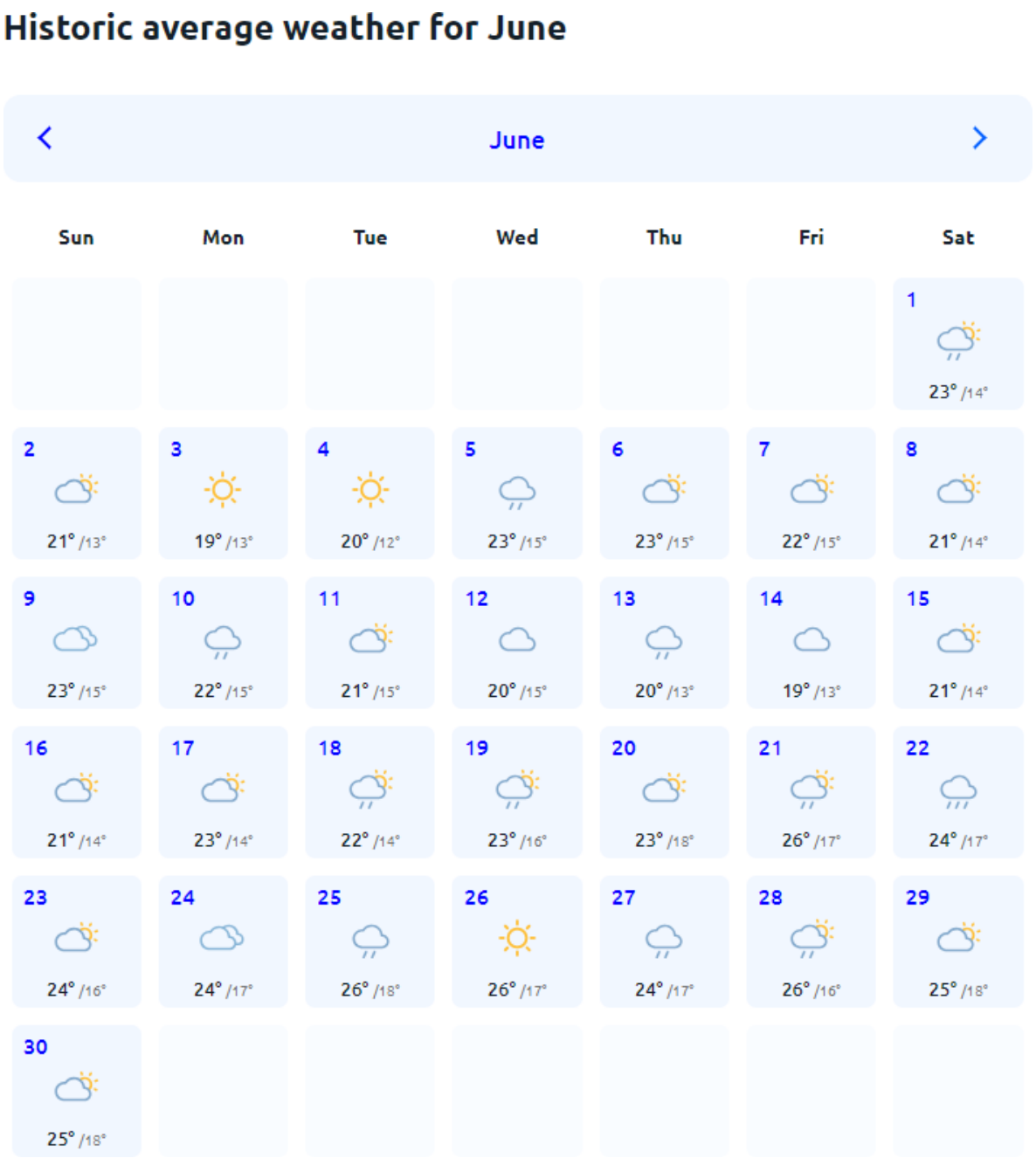


Photo 7 Weather forecast of June 2024

Editorial contributions:

Kiran Hari Pradhan

Manjul Acharya

Mukesh Pandey

Sudip Koirala

Photo Courtesy:

Manjul Acharya

Sponsored by:

Shantou University
(Diamond Sponsor)

Geomaple Geotechnics Inc.
(Gold Sponsor)

Altitude Geospatial Incorporated
(Supporting Partner)

Global Institute for Interdisciplinary Studies
(Supporting Partner)

GMH Engineering
(Supporting Partner)

Maha Lachchya Services (MLS)
(Supporting Partner)

Result Build Inc.
(Supporting Partner)

<u>Editors:</u>

Dr. Suman MANANDHAR

Prof. Fauziah AHMAD

Dr. Babloo CHAUDHARY

Dr. Arvind Kumar JHA