

Geotechnical Session Abstracts – ISGSR 2027

S1: Slope Reliability: From Theory to Practice

Organised by Ashley Dyson and D. Vaughan Griffiths

Probabilistic and reliability-based methods for slope assessment take center stage, emphasizing the transition from theoretical development to engineering decision-making. Case studies from infrastructure, mining, and natural hazard projects illustrate how uncertainty-aware designs optimize safety and cost. Discussion covers modeling spatial variability and Bayesian updating of parameters as integral parts of modern geotechnical workflows.

S2: Linking AI to Real Engineering Examples, Projects and Practice

Organised by Ze Zhou Wang and Zenon Medina-Cetina

Many practicing engineers remain hesitant to adopt AI in their daily workflows, creating a gap between research and industrial application. Presenters share empirical evidence and successful field implementations to demonstrate the reliability of AI in site characterization and hazard management. These real-world examples prove that data-driven technologies can align with existing engineering standards and practices.

S3: Multi-Hazard Risk Assessment and Urban Resilience in Multi-Asset Urban Systems

Organised by Yanhao Zheng and Jinhui Li

Urban areas face complex, cascading threats from floods, earthquakes, and landslides that impact critical infrastructure and services. Researchers examine system-level resilience through probabilistic modeling and GIS-based multi-hazard mapping. Contributions integrate scientific analysis with practical disaster management strategies to identify vulnerabilities and assess adaptive capacities in cities.

S4: Geotechnics on the Moon: Challenges and Future Directions

Organised by Marcin Chwała

Building infrastructure on the Moon requires a fundamental shift in design paradigms to handle extreme environments and sparse data. Key topics include the mechanical behavior of regolith, slope stability in crater terrains, and the characterization of potential habitats like lava tubes. This field leverages probabilistic approaches and uncertainty quantification to support reliable construction in extraterrestrial environments.

S5: Reliability Assessment of Existing Geotechnical Structures

Organised by Timo Schweckendiek and Kerstin Lesny

Aging geotechnical assets like foundations and embankments require robust, data-informed assessment frameworks to ensure continued safety. Presentations focus on reliability updating through field monitoring and remote sensing to inform risk-based asset management. A panel debate addresses practical barriers to implementing these methods in routine industry practice and how to communicate uncertainty to decision-makers.

S6: State-of-the-Art of RBD in the Geotechnical Engineering Practice

Organised by Julia Sorgatz, Patrick Arnold, Axel Möllmann, and Kerstin Lesny

International standards such as Eurocode 7 are driving the adoption of Reliability-Based Design (RBD), yet its practical use remains inconsistent across different countries.

Participants discuss implementation strategies and the roles of designers, contractors, and clients in communicating uncertainty throughout a project's lifecycle. Practical experiences help bridge the gap between scientific advances in probability and everyday engineering tasks.

S7: Machine Learning for Geotechnical Reliability Analyses

Organised by Ivan Depina, Zhongqiang Liu, and Emir Ahmet Oguz

Advanced machine learning techniques offer ways to improve the efficiency of reliability models by replacing heavy computations with high-accuracy surrogate models. Discussion revolves around Physics-Informed Neural Networks (PINNs) and scientific machine learning (SciML) as tools for improved forward and inverse analyses. Authors also tackle data limitations and the "black-box" nature of high-dimensional approaches to increase model interpretability.

S8: Machine Learning based Multimodal Data Fusion in Geological Uncertainty Modelling

Organised by Jinzhang Zhang, Zheng Guan, Michael A. Hicks, and Dongming Zhang

Integrating sparse boreholes with CPT and geophysical surveys allows for more accurate spatial variability modeling. This approach shifts subsurface characterization from deterministic geological layers to dynamic, probabilistic models that quantify uncertainty. The result is a data-driven framework that bridges academic AI research with practical risk evaluation in real-world projects.

S9: Physics- and Data-Driven Modelling for Climate Risk Assessment of Geotechnical Infrastructure

Organised by Pin Zhang, Haoyuan Liu, Stephen Suryasentana, and Zenon Medina-Cetina

Multi-hazard conditions like storm surges and heavy rainfall challenge isolated modeling approaches for critical infrastructure. Hybrid frameworks merge physics-based robustness with data-driven efficiency for real-time monitoring and adaptive risk assessment. Topics include digital twins and uncertainty-informed decision-making in the face of interacting climatic hazards.

S10: Climate Change Impacts on Geotechnical Safety and Risk: Assessment and Adaptation

Organised by Emir Ahmet Oguz and Ivan Depina

Quantifying climate-related risks is essential for establishing robust mitigation frameworks for foundations and earth structures. Research highlights failure mechanisms like rainfall-triggered landslides and the limitations of using historical data for future geotechnical designs. Practical adaptation strategies, such as advanced drainage systems and bio-engineered stabilization, are explored to ensure infrastructure resilience.

S11: From measurement to reliable site characterization – ways to fulfil the gap between test points

Organised by Jędrzej Wierzbicki

Subsurface investigations typically rely on discrete point measurements, yet designers need a continuous picture of subsoil properties across the entire site. Geostatistics, Bayesian updating, and machine learning provide tools to fill these information gaps between test

points. The discussion focuses on the interpolation problem and the propagation of site-characterization uncertainty into risk-informed design.

S12: GeoEngineering Modelling leveraging datafusion and datadriven strategies

Organised by Giovanna Vessia, Wojciech Puła, Diego Di Curzio, Joanna Pieczynska-Kozłowska, Marek Kawa, and Dematteis Antonio

Heterogeneous soils and rocks necessitate engineering decisions made under both inherent geological variability and epistemic uncertainty. Contributors discuss data-fusion strategies and hybrid models to enhance predictive capability for foundations, tunnels, and slopes. Emphasis lies on integrating CPT, geophysical, and laboratory data into 3D spatial models for geotechnical characterization.

S13: Non-deterministic resilience-based management of geotechnical systems

Organised by Marco Uzielli, Andrea Geppetti, and Stefano Collico

Geotechnical resilience covers the capacity of systems to resist, recover from, and adapt to natural or human-made disturbances. New probabilistic formulations move away from deterministic indices to account for aging and non-stationary climate hazards. This shift provides a more transparent basis for performance assessment by incorporating monitoring data into life-cycle reliability models.

S14: Modelling Spatial Variability in Geotechnical Engineering

Organised by Jinsong Huang, Shui-Hua Jiang, Jiawei Xie, and D. Vaughan Griffiths

Soil properties show natural variability that significantly impacts the reliability of tunnels, piles, and foundations. Random field theory and machine learning provide frameworks for characterizing heterogeneity even when site data is sparse. Research focuses on theoretical developments and numerical methods to simulate non-stationary soil properties and large-scale 3D fields.

S15: Probabilistic Geotechnical Site Characterization in AI Era

Organised by Yue Hu, Zheng Guan, and Yu Wang

Digital transformation tools like Bayesian inference and digital ground modeling improve the interpretation of complex site conditions. Probabilistic frameworks help quantify the uncertainty caused by limited sampling, spatial variability, and transformation models. Professionals share experiences using multi-source data fusion and digital twins to optimize site investigation strategies.

S16: Risk Assessment and Mitigation of Geological Hazards or Hazard Chains

Organised by Xin Liu, Dianqing Li, and Kok-kwang Phoon

Climate-driven threats often occur as hazard chains, such as landslides leading to dam breaches and subsequent flooding. Robust risk assessment methodologies quantify these multi-hazard dynamics to better protect communities and infrastructure. Studies focus on reducing vulnerability and developing risk-informed policy frameworks for resilient infrastructure design.

S17: Bayesian analysis of geotechnical data

Organised by Iason Papaioannou, Nezam Bozorgzadeh, Yu Feng, Zijun Cao, and Daniel Straub

The Bayesian framework integrates in-situ measurements and engineering judgment to update model parameter estimates and system reliability. This approach supports model

selection and helps characterize spatially variable properties from limited datasets. Practical applications include reliability updating, the observational method, and the design of optimal site investigations.

S18: AI-Driven Geotechnical Risk Analysis: Challenges, Opportunities, and Future Directions

Organised by Pijush Samui and Anasua GuhaRay

New opportunities in geotechnical risk analysis emerge through the use of Generative AI and Large Language Models. These tools assist in uncertainty quantification and real-time decision-making for structures like foundations and tunnels. The objective is to merge data-driven techniques with traditional reliability and risk assessment methods for more economical design.

S19: Reliability-based analysis and design of soil-structure interaction problems

Organised by Richard Bathurst and Reza Jamshidi Chenari

Specialized analysis and design procedures focus on the probabilistic interaction between structures and the surrounding ground. This area covers foundations and retaining walls where soil-structure interaction is a critical factor in ensuring safety under uncertainty.

S20: AI/data-driven probabilistic site characterization and risk assessment

Organised by Jianye Ching and Zhiyong Yang

Machine learning aids in translating sparse site data and abundant historical records into reliable, risk-informed decisions. Researchers present advancements in 3D site reconstruction and physics-informed surrogates for accelerated slope and tunnel stability analysis. Innovative solutions use Large Language Models (LLMs) to drive automated reliability analysis and design.

S21: Digital Twins and BIM in Geotechnics

Organised by Jelena Ninic, Brian Sheil, and Zefeng Zhou

Building Information Modeling (BIM) and Digital Twins serve as central frameworks for managing geotechnical data throughout a project's lifecycle. These technologies improve the visualization and integration of ground information, supporting more informed decision-making in construction.

S22: From Variability to Value: Integrating Uncertainty-Aware Geotechnical Methods into Offshore Renewable and Oil & Gas Design

Organised by Francesca Zolezzi and Nejan Huvaj

Offshore wind and oil and gas projects face complex geological settings where deterministic safety factors can lead to excessive costs. Value of Information (VoI) analysis and Random Field Modeling help integrate soil variability directly into offshore engineering workflows. Real-world case studies show how uncertainty-aware methods influence final design procedures and regulatory approvals.