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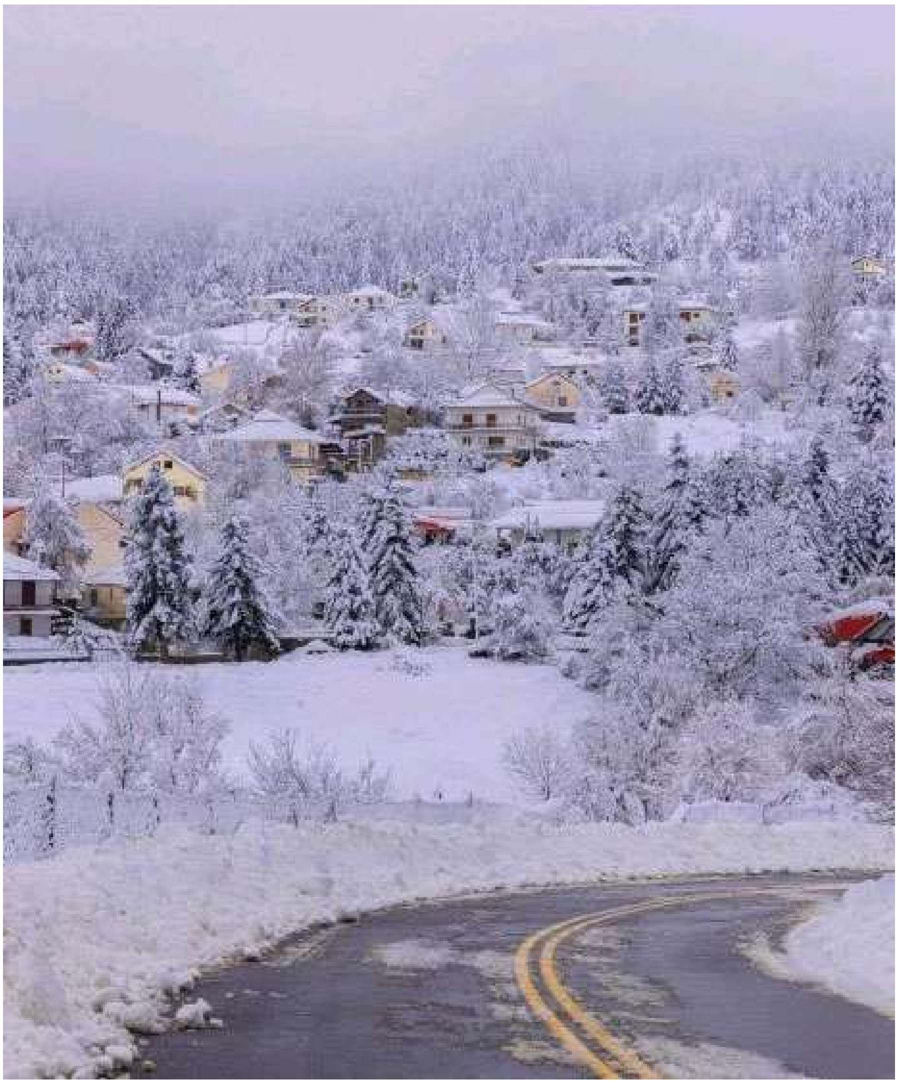

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Γρεβενά

How geotechnics can make life simpler, safer and more certain for infrastructure projects

For any transportation project it's essential to have a clear view of the subsurface and any problems that may arise. What 'lies beneath' will invariably have a major impact on project progress and budget adherence – and geotechnics has a key part to play in revealing it.

Contributors to this article include recent speakers at Seequent's Lyceum 2021. Speaker Ray Yost, Principal Geotechnical Engineer, Advisian discussed 'Understanding geotechnical risk: A structure for uncertainty.' And a panel of industry thought leaders from Mott MacDonald, DB Engineering and Arcadis, discussed the benefits of digital ground modelling and how it has improved project outcome and what still needs to change in the near future.

Reducing geotechnical uncertainty in turn increases project certainty and decreases the risk of delays and expensive budget overruns. Being able to incorporate new information in near real-time can also be invaluable in accelerating delivery and cutting costs.

Innovation and digital transformation have a major role to play in bringing the subsurface and surface together. Together they can help deliver sharper insight, make short work of common problems, maintain the highest of professional standards and provide an encyclopedic resource for the whole lifecycle of structure.

From planning and investigation, through design and construction, to operation and maintenance, each stage requires the analysis of geotechnical risk. And as climate change presents us with unprecedented environmental challenges, technology is a lever we can pull to help us meet them and drive essential infrastructure projects forward.

So, how can we make that happen and what are the obstacles in the way? Here are eight points to consider.

1. Understanding the rules of geotechnical risk

Geotechnical engineers are often dealing with small data sets – whether small in value or sample to volume ratio – and this adds to the uncertainty. The properties of geomechanics are inherently variable and difficult to obtain, which adds to the uncertainty. How then can we properly understand geotechnical risk?

Ray Yost says it's about allocation and audience. "When thinking about the allocation of resources there is a structure to uncertainty. There the tools that we have as geological engineers to help us think about that. And when we start to marry the circumstances of uncertainty and the tools we have for addressing it, we really want to ensure it produces an optimal allocation of resources."

Ray characterises risk as a function of the relationship between uncertainty and proposes a framework that matches tools to risk character in order to improve risk assessment outcomes (see Figures 1 and 2).

"And when we talk about uncertainties with our model we have to talk about risk in terms of what impacts the audience. For instance, if it's mining engineers, you'll talk about impacts on their schedule, production, access, budgets, income streams. The first rule of communicating geological engineering is don't talk about geological engineering."

"The first rule of communicating geological engineering is don't talk about geological engineering!"

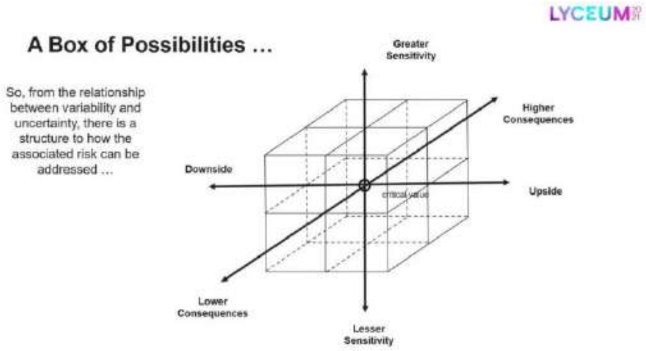

Figure 1 – looking at risk as a function of uncertainty.

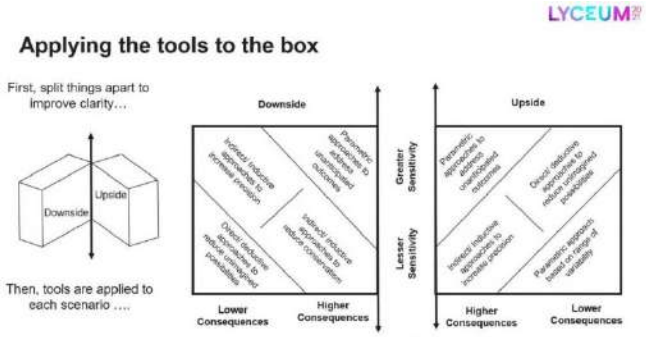

Figure 2 – Applying the tools to the box.

Just as there's a cost associated with the downside of unmitigated liability, there's an opportunity cost associated with the upside consequences, Ray comments, "We could have had leaner and meaner construction, we've dedicated resources that we didn't need to."

2. Better communication, better collaboration, better outcomes

This is where digital innovation is already helping in ground engineering. Ground conditions are increasingly being incorporated into the BIM environment, strengthening collaboration and improving outcomes from tendering to in-project coordination and material reuse. For example, the tendering process is simplified when contractors have detailed information about soil and rock volumes. Bernd Heer, Senior Geotechnical Consultant at DB Engineering & Consulting GmbH, notes that, "During the production and conception process, there is less discussion with the contractors (on the interpretation and assumptions of the data), which helps the project in general."

Enabling soil property information to be analysed and visualised in 3D improves the understanding of the data and also the communication with the wider project team and stakeholders. Peter Fair, Geotechnical Data & 3D Ground Modelling Specialist, Mott MacDonald UK, notes that, "being able to analyse the Earthwork Material test results and compare that with the directly with the geological model directly within the BIM environment adds real value. One of the really key benefits is it now allows us to see not only the percentage and volume of the different materials but how easy it's going to be to excavate and ability to be reused. We can see and understand that now much easier within the 3D model."

3. As climate change worsens, we must react faster to save infrastructure and lives

Geotechnics and the role of civil and environmental engineers will increase substantially as climate change impacts and mitigations become more apparent. After all, we work in the environment; it's where our structures exist.

Technology is an important lever we can pull to help us face these environmental stresses and strains. The ability to understand the ground through sophisticated 3D modelling and being able to see it rapidly with, for instance, a deployment of a drone, means it's possible to see a slipped cutting or embankment and not have to wait for a topography survey. As Peter Fair, Mott MacDonald UK, puts it, "When we have digital assets we can respond quicker, information is at our fingertips and we can make data driven decisions and respond in a more informed way."

As data from the plethora of deployed sensors (the internet of things) becomes more usable, it can help us get ahead with managing and mitigating climate change. Bernd Heer, DB Engineering & Consulting GmbH sees huge potential in this approach, informed by his experience of the catastrophic 2021 German floods that completely destroyed infrastructure. "If we have weather prognosis systems and we combine this with what we know of the terrain, sensors can actually talk to our structural assets. I can then envisage that the structure puts out warnings about what's going to happen within set parameters.

"Even if we can't save the infrastructure itself we can save human lives."

4. The more you know, the leaner you can design

Digital workflows can lead to a leaner design resulting in lower environmental impact, explains Andrea Gillarduzzi, Technical Director, Geotechnical Engineering, Arcadis Consulting (UK) "If we start using BIM and digital tools in a cleverer way, we would be able to obtain much more significant data about the real range of behaviour of the infrastructures and that might result in a more economic design. We would be able to maintain the infrastructure in a more effective way…. that has less impact on the environment.

When you obtain the data, you would not necessarily know all possible ways it might be used for, but if you've got it you can decide." As Seequent's Gareth Crisford, Regional Head of Civil, Environment and Energy, EMEA, puts it, "If you use all the data you have and have a custom maintenance system on the asset, you can look back over the asset's life and see how it could have been designed differently and leaner; this leads to a continual cycle of learning."

5. Infrastructure assets are already talking to us. Are we listening?

The move to the Internet of Things is, of course, well underway, with seemingly countless sensors collecting data in any manner of different ways. In fact, the mountain of data they are collecting is daunting. For decades Infrastructure assets have been installed with these sensors, with also the potential to retrofit them, but probably only now it is within the industry's grasp to use the data more extensively.

Andrea Gillarduzzi says, "The present technology is going to use this data in a more effective manner to transfer the information rather than it being owned by a single project or single entity."

Bernd Heer explains, "There's a midterm effect, in the next five years, where we'll learn to integrate the available data much quicker. For me this is mostly in the design phase, where we can start doing automated foundation design."

6. How could life change for the geotechnical engineer in this new era?

Will it mean a significant shift to more of a curator of results that have been automatically gathered by sensors and different systems from historical sources?

Bernd Heer can see this, "We as geotechnicians will only look, curate and validate data before it gets put into the system. There will be a lot less report-writing, a lot less checking for drawings, a lot less setting up meetings, talking about what that actually means because we will all agree on the available data."

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And as data is coming from different independent sources this will also help with validation. As Andrea Gillarduzzi explains, "If you are monitoring an expansion joint of a bridge, and you combine it with meteorological monitoring, and with traffic data over a given period, you may get to understand better the wear of the joint, design and maintain it differently and so on. Lots of data can be easily obtained by embedding sensors and other tech in what we build or by retrofitting it."

As outlined, much of this is already underway with data being actively recorded but not yet extensively used. For example, the torque used by a drilling rig can give information about the strengths of the rock and soil.

Peter Fair sees the potential for bringing the data gathered on drilling rigs into the design process. "We've done an initial design, and then we're onsite drilling, and using that data in a way that can directly influence the design almost as the asset's being constructed. And then longer term, with AI, I could see that we use that data for automated design and we become the checkers and approvers of an automated design. We're starting to see that now with CPT assessments where the AI is doing better assessment and making less errors than some of the human resources."

7. Is the industry ready for automated design?

Automatic design is already happening in other areas, particularly for linear jobs, for example drill and blast. We effectively position the drilling holes for the best position to obtain the best rate of production, the safest production, and avoidance of over-excavation, over-profiling.

But a leap to automated design will require significant thought change within the industry, adapting design during the construction process will for instance have implications for regulation.

Bernd Heer comments, "Within the civil engineering community in Germany the design has to be checked and approved by the states and local government. So, you have to provide an automated circle system that actually repeats that approval very quickly, so you can adjust the design onsite. It's a big step for everybody involved in the industry, and we have to walk that way, but we're not there yet, at least not here."

8. The importance of standards *vs* the willingness to share...

International standards, like ISO 19650, are already improving the digital project with the organisation and digitisation of information about civil engineering works, including BIM. A single model provides a single understanding but we're still facing a challenge as an industry over the transfer of data and the definition of ownership and the liability attached to it.

Andrea Gillarduzzi comments, "At present, we are faced with a concern that sharing data increases our liability, and this discourages collaboration between the different parties, and is something which I believe we need to overcome as soon as possible before we lose an immense opportunity."

There's also the issue of data not being collected or saved. But just collecting the information, making sure it's stored in a reusable way is key, with ISO 19650 enabling us to keep reaching towards it.

And although we're in a data age we have to consider whether for some assets it's worth the cost of data storage. For critical infrastructure there's no question but is this the case for every single asset? And keeping the data updated is another important consideration adding to the systemic challenges the industry needs to define and agree, what to save, what not to save and what is the liability, exposure and risk during a project. And when models are passed on from one consultant to another, how do we ensure that it is able to be used by the ongoing consultant?

Peter Fair comments, "So often we don't have the assurance of that model. And then as a consultant, we feel that we have to rebuild that model from scratch just to prove to ourselves that it is of the required level, and that seems to undermine all this."

And yet we share what we consider to be factual data, but any ground model is inherently an interpretation. And so, in many respects when we share a model we already share a liability and we need to acknowledge that.

Technology can help to overcome subjectiveness, for example scanners for a solid core of rock, are not just optical but X-ray or colour infrared, squeezing even more data from the source. And there is a lot of new technology, which in future, will help us to get a more rounded experience of what happens in the field, with augmented reality, fully immersive VR and so on bringing a new layer of multi-sensory data which is presently completely disregarded.

There are obstacles, but they can be overcome

And there are, of course, many obstacles to the introduction of advancing technology.

- Software providers are often criticized for being proprietary and not open to all users.
- Then there is the steep learning curve in keeping up with technology.
- We face the very real risk of a disconnect between the tech savvy young and the older more experienced generation with 20-30 years of valuable knowledge and experience under their belts.
- And to be successful, digital has to be all together, with no one left behind.

Some very meaty challenges lie ahead for the industry. As Gareth Crisford says "We're on a continual journey where we're trying to be open to all. Openness and interoperability are driving forces within Seequent, it's our life blood. For instance, we're currently developing open APIs into our cloud repository, so we can help leverage all the best-in-class new geotech technologies out there. We're known for our ease of use and data openness and we're ready to help geotechnical engineers face the challenges of the future."

(SEEQUENT, November 14, 2021, https://www.seequent.com/how-geotechnics-can-make-life-simpler-safer-and-more-certain-for-infrastructure-projects)

ΑΡΘΡΑ

Emergency Rock Slide Stabilization with Shear Pins

Sebastian Lobo-Guerrer & Todd DeMico

Tension crack along top of the cut

On Easter Sunday, March 27, 2016, a landslide initiated in an existing rock cut located uphill from a shopping plaza in Altoona, Pa. The landslide created tension cracking along the existing rock cut, and during a period of weeks the tension cracks expanded from inches to feet (mm to meters). Survey readings indicated that portions of the slide were moving at a rate of approximately 2 in/day (5 cm/day). In addition to the shopping plaza, high voltage electric lines and an underground gas line ran along the base of the rock cut, further prioritizing the need to mitigate the failure as quickly as possible. Due to the rate at which the rock mass was sliding and the associated potential danger below, a plan was rapidly implemented to secure the hillside. The plan involved constructing a temporary rock buttress, removing most of the slide mass, securing the bedrock upslope of the tension crack with shear pins, and final reconstruction and grading of the slope. The inherent danger that quickly developed from the slide failure led to intense media coverage, with some positive and negative impacts.

Slope Failure and Preliminary Investigation

The failure of the slope was first observed when tension cracks were discovered along the top of the rock cut, which was constructed more than a decade before the failure. Once the failure was identified, the site owner quickly began an investigation and contacted The EADS Group for engineering services (slide monitoring and project coordination) and A.G.E.S. for geotechnical design of the slide remediation. The site investigation was performed as quickly as possible, and revealed that bedrock along the cut consisted of sandstone with interbedded shale with a bedding dip of about 16 degrees. The orientation of the dip was downslope along and toward the cut.

A drainage ditch was present upslope of the failure scarp, and was intended to divert water from wetlands upslope. It was noted that trees were growing along the drainage ditch. Water flow within the ditch seemed to "disappear" in the region closer to the scarp. It was believed that surface runoff had been flowing into the slide rather than following the path of the constructed drainage ditch. Water could be heard flowing within the tension cracks of the slope failure, and seepage was observed along the slope. In an effort to reduce future movement, the water in the ditch (region of groundwater infiltration) was temporarily diverted by pumping until the ditch and slide could be repaired.

Tension crack at the back of the slide mass

The results of the site investigation suggested that the mode of failure was due to weathering and degradation of thin shale layers within sandstone. These shale layers weathered over time due to groundwater infiltration, and produced a slide surface for the bedrock above. Based on the tension cracks observed at the site, it was estimated that the size of the sliding mass (interbedded sandstone and shale block) was approximately 400 ft (122 m) wide by 150 ft (46 m) upslope by 20 ft (6 m) thick.

Slide surface observed during the site investigation

The EADS Group surveyed points along the slope two times a week to estimate the rate and direction of movement. It was determined that the sliding block was moving at a rate of approximately 2 in/day (5 cm/day). Based on the survey, locations above the tension cracks indicated no movement further upslope. Based on the rate of movement, the size of the failure, and the inherent risk for the shopping plaza, the high voltage electric lines at the base of the slope were de-energized. A few stores within the shopping plaza were required to operate on gas generators due to the de-energized electric lines.

The Role of the Media

The shopping plaza, an underground gas line and high voltage electric lines at the base of the existing failure quickly made headlines on the media. Media coverage of the site provided benefits and disadvantages to the project.

There were many valuable contributions from the media during the site investigation and stabilization work. Continuous news reports provided updates and weather forecasts during the slide repair. In addition, video coverage of the site often included footage from drones, which provided unique views of and insight into the tension crack pathways that would not have been possible otherwise. The views from the drones provided better understanding of the failure mechanism as well as continuous updates to the public. Social media also included "Facebook updates," and, in general, social networks coverage brought significant attention and advertisement for the shopping mall and its stores.

There were also a fair number of negatives from the news reports. Many of the reports contained information that was often not accurate or was overly dramatic, which created unnecessary anxiety for the public about the safety of the surrounding area. These reports often included potential causes of the failure and proposed mitigation treatments that were inaccurate. The misleading nature of this information and the spotlight that these reports projected on the project added another aspect of stress during the overall stabilization efforts. A few examples include statements such as: "cracks opening from 1 ft to 15 ft (0.3 to 4.6 m) wide in one week," or referring to the slide as an "expanding fault with potential to collapse," which is not technically correct. Some inaccurate reports also speculated that if the electric posts were hit by the slide the "whole area will be electrified," and the "hill side would break apart." Other reports indicated that the "police" were very concerned, when, in reality, the cooperation with the local authorities was remarkable.

Drone coverage of the failure *(provided by PA SkyOps)*

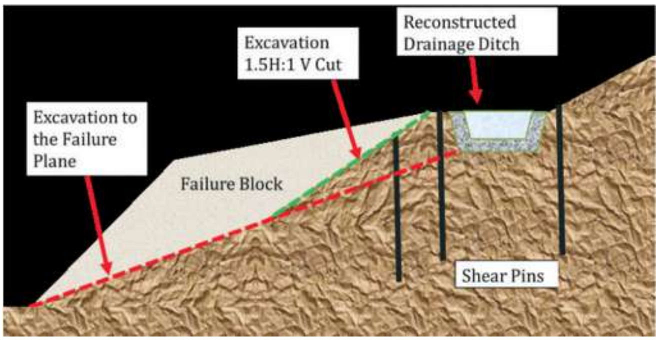
Landslide Remediation Design

Following the site investigation, the engineering team developed a landslide treatment in an expeditious manner. In the end, two alternates were selected as the most feasible options. These options were then relayed to the site owner and local contractors to determine the best option for the site.

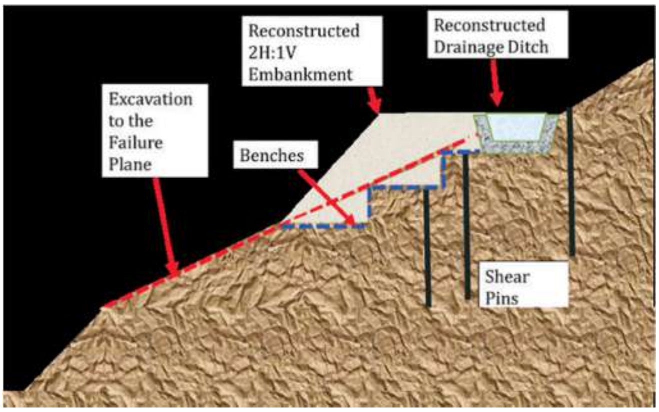
The first option consisted of a permanent rock buttress at the base of the original rock cut. The buttress was to be constructed with borrow rock with dimensions determined from stability analyses of the slope. To stabilize the upper portion of the slide and to prevent cracking further upslope, the existing tension cracks were to be backfilled with rock or grouted. Although stability analysis for this proposed alternate indicated that it was feasible, site constraints, such as the space taken by the permanent buttress, made this option less attractive.

Due to the location of the rock cut with respect to the existing shopping center, a permanent rock buttress would significantly reduce access for trucks delivering goods to the commercial buildings. In addition, there were concerns with how the existing gas line, the electric lines and drainage at the toe of the slope would be affected by the permanent rock buttress. The permanent rock buttress was ultimately ruled out when it was determined that construction would be delayed as much as two weeks due to quarrying and transporting the rock to the site. Given the rate of movement of the slide and the growing operating expenses to the shopping plaza for the gas powered generators, this option was eliminated.

The second alternate consisted of removing the existing failure mass and using a portion of the rock from this zone as a temporary buttress to prevent future failures. Since the existing material contained degradable shales, this buttress was not considered a permanent solution. Instead, the failed rock mass could be left in place until shear pins were installed above the existing slide surface. The shear pins would be used to prevent additional tension cracks from forming after the removal of the existing failure mass. With the upper slope stabilized, the temporary buttress could then be excavated and the slope regraded up to the elevation of the shear pins.



Section view of model 1 of the "second alternate"



Section view of model 2 of the "second alternate," where slope reconstruction was required

Engineering Analyses

The second alternate was chosen as the preferred option as it allowed work to begin immediately to help support the sliding mass temporarily. Based on the rapid pace in which work was required, design for the shear pins began at the same time as the construction of the temporary buttress. The sizing and spacing of the shear pins were determined based on the assumption that a 20 ft (6.1 m) tall by 150 ft (46 m) long (upslope) mass would fail along the slide surface at a dip angle of 16 degrees. These dimensions were estimated based on the size of the sliding block failure present at the time of design (i.e., it was assumed that a future failure would be similar in size to the failure that already occurred for which the stabilization was required). The design of the shear pins assumed that the material in front of the block would not provide any resistance.

The size, spacing and embedment depth of the shear pins were computed using the commercially available program SLIDE such that a minimum factor of safety (FS) of 1.5 was provided. The friction angle of the slide material was back calculated using SLIDE to determine the shear strength of the material that would result in FS = 1.0 (i.e., the existing condition). Based on the analysis, the friction angle of the sliding surface was estimated to be approximately 16 degrees. Since this friction angle was for the region that had already failed, this value considered to be the residual shear strength of the degraded shale layer below the area where tension cracks had developed. As the shear pins were to be designed for the region above (upslope of) the tension cracks where no readily noticeable signs of failure were observed, a fully softened friction angle of 20 degrees was assigned (and was supported by laboratory testing) to the weathered shale. The fully softened shear strength was meant to account for weathering of the shale layer that resulted in a weakened shear strength condition compared to that of peak strength (unweathered condition). Weathering of the shale layer is the failure mechanism that likely created the initial slide.

The shear strength of the proposed steel reinforcement bars was considered and modeled in SLIDE to properly size the shear pins, to stabilize the failure block and to satisfy a FS = 1.5 using a fully softened shear strength of the rock. An additional check was done to verify that the design solution provided a FS ≥ 1.1 for the residual shear strength condition. Both analyses included a tension crack filled with water at the back of the slope. The shear pins extended 10 ft (3 m) below the potential failure plane to provide resistance against a passive failure in rock and to provide fixity at the pin tip with an additional FS = 2.0. The total bar length was 30 ft (9.1 m).

A #20 (No. 64), 75 ksi (517 MPa) steel epoxy coated, reinforcing bar was considered for analysis. Based on the SLIDE analysis, the maximum center-to-center spacing for a #20 bar was approximately 8 ft (2.44 m) within a row, with a minimum of two rows. Conservatively, a third row of nails was used in the critical areas. Although the shear pins were to consist of #20 steel reinforcing bars placed in a 6 in (152 mm) diameter hole and encased with 3 ksi (20.7 MPa) grout, the shear strength calculations (conservatively) considered only the shear resistance from the steel reinforcing bar and neglected the shear resistance provided by the grout. A FS = 1.5 was applied separately to the shear strength of the bar. The final design of the slope required 110 shear pins along the slope.

Landslide Remediation/Slope Reconstruction

The construction of the temporary rock buttress began while design of the shear pins was being finalized. The construction sequence consisted of removing rock below the tension crack down to the depth of the failure plane and reusing the material for the temporary buttress. Once the slope was stabilized by the temporary buttress, three rows of shear pins were installed by Brayman Construction over a span of approximately three weeks.

Following the installation of the shear pins, the removal of the temporary buttress commenced. Some of the material from the temporary buttress was used for regrading the upper part of the slope. However, due to the slaking potential of the material, the rock fragments were broken down and placed at a 2H:1V slope as soil (i.e., placed and compacted in 8 in [203 mm] lifts).

Installation of shear pins upslope from the existing failure

Once the slope was sufficiently stabilized, power was restored to the electric lines within the shopping plaza after being deenergized for approximately one month during construction.

In addition, after the slope was stabilized, reconstruction of the drainage ditch above the failure began where a new impervious liner was installed to prevent excess groundwater infiltration along the slope (a large contributing factor to the initial failure). The riprap lining in the drainage ditch was removed and the existing impervious liner was replaced. During the removal process, it was determined that the original impervious liner had been significantly damaged by the roots of the trees growing along the ditch. This damage resulted in a significant amount of groundwater infiltration above the slide. A new geosynthetic clay liner (GCL) was installed and the original riprap was reinstalled along the drainage ditch.

Project completion in December 2016

Conclusion

The regrading of the slope and installation of the new GCL in the drainage ditch marked the end of the stabilization and remediation. The upper channel was reopened in October 2016, and the overall project was completed in December 2016 when the toe of the temporary buttress was removed. Once construction was completed, guy wires and support posts were reinstalled by the electric company along the slope.

Given the circumstances at the beginning of the slide failure, the overall project was an outstanding success. The failure did not advance far enough to encroach onto the property below or to create significant risk to the public at large. These dangers were avoided because of the quick response by the site owner, the engineering team and the different contractors. Following construction, additional surveying of the slope indicated no further movement.

This project demonstrated how shear pins could be a cost-effective remediation tool that can be installed in a timely manner. This solution is particularly suited for cases with very defined shear planes in bedrock, where the reinforcing elements are controlled by shear resistance and not bending resistance (governs in most soil slides).

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Todd DeMico, P.E., is a geotechnical project engineer at A.G.E.S. in Pittsburgh, Pa. He has more than six years of geotechnical experience in the design of bridge foundations, earth retaining structures and soil/rock slide stabilization.

(DEEP FOUNDATIONS, MAR/APR 2018, pp.83-86, http://dfi.dcatalog.com/v/March-April-2018/?page=2)

The influence of off-fault deformation zones on the near-fault distribution of coseismic landslides

Colin K. Bloom, Andrew Howell, Timothy Stahl, Chris Massey and Corinne Singeisen

ABSTRACT

Coseismic landslides are observed in higher concentrations around surface-rupturing faults. This observation has been attributed to a combination of stronger ground motions and increased rock mass damage closer to faults. Past work has shown it is difficult to separate the influences of rock mass damage from strong ground motions on landslide occurrence. We measured coseismic off-fault deformation (OFD) zone widths (treating them as a proxy for areas of more intense rock mass damage) using high-resolution, three-dimensional surface displacements from the 2016 Mw 7.8 Kaikōura earthquake in New Zealand. OFD zones vary in width from ~50 m to 1500 m over the ~180 km length of ruptures analyzed. Using landslide densities from a database of 29,557 Kaikōura landslides, we demonstrate that our OFD zone captures a higher density of coseismic landslide incidence than generic "distance to fault rupture" within ~650 m of surface fault ruptures. This result suggests that the effects of rock mass damage within OFD zones (including ground motions from trapped and amplified seismic waves) may contribute to near-fault coseismic landslide occurrence in addition to the influence of regional ground motions, which attenuate with distance from the fault. The OFD zone represents a new path toward understanding, and planning for, the distribution of coseismic landslides around surface fault ruptures. Inclusion of estimates of fault zone width may improve landslide susceptibility models and decrease landslide risk.

INTRODUCTION

Coseismic landslides are among the most widespread and impactful hazards resulting from earthquakes (e.g., Marano et al., 2010). As such, it is critical to identify and mitigate landslide risks to human life, buildings, and other vulnerable infrastructure prior to major earthquakes. Coseismic land-slide susceptibility models (e.g., Xu et al., 2012; Reichenbach et al., 2018) that rely on a combination of geologic, hydrologic, morphologic, and seismologic parameters are used to inform policy makers and emergency management plans. Despite an increasing global catalogue of landslide inventories, regional coseismic landslide models still rely on predictor variables that have major epistemic uncertainties. One of the most important variables that has yet to be sufficiently explained is "distance to surface fault rupture," which has been used to account for the higher density of coseismic landslides commonly observed near surface-rupturing faults in coseismic landslide inventories (Xu et al., 2012; Fan et al., 2019; Massey et al., 2020).

This higher incidence of landslides near faults has been attributed to two broad categories of physical processes: (1) stronger ground motions that attenuate with increasing distance from seismic sources (Meunier et al., 2007; Tatard and Grasso, 2013), and (2) geologic conditions and seismic site characteristics resulting from lithological contrasts, topography, and rock mass damage near faults (Ben-Zion and Sammis, 2003; Kim et al., 2004; Meunier et al., 2008; Gallen et al., 2015; Peacock et al., 2017; Wang et al., 2019). Defining the influence of each broad category, and the variables within them, is challenging and has limited the utility of "distance to fault" as an empirical parameter (Gallen et al., 2015; Parker et al., 2015; Reichenbach et al., 2018).

Advances in quantification of coseismic off-fault deformation (OFD) following earthquakes (e.g., Quigley et al., 2012; Zinke et al., 2014, 2019; Milliner et al., 2015, 2016) provide the opportunity to test the influence of OFD on coseismic landslide distributions. OFD is defined as secondary faulting, warping, granular flow, and other brittle deformation that distribute slip off the primary fault plane during earthquakes, producing permanent tectonic coseismic strain (McGill and Rubin, 1999; Milliner et al., 2015). Coseismic strain contributes to cumulative rock mass damage, but, in a positive feedback loop, this damaged rock mass is more likely to experience greater coseismic strain (Ostermeijer et al., 2020). Consequently, the area of OFD about the fault, or the OFD zone, might approximate an area of reduced rock mass strength that amplifies seismic waves and predisposes slopes to fail under lower stresses (Kim et al., 2004; Parker et al., 2015). Effectively, the OFD zone may serve as an approximation of the local site characteristics that influence coseismic landslide distributions near the fault.

We calculated static surface displacement fields from the 2016 Mw 7.8 Kaikōura (South Island, New Zealand) earthquake and estimated the width of the OFD zone around 14 surface-rupturing faults. We then compared the decrease in landslide density with increasing distance from surface fault rupture, using the latest 2016 Kaikōura earthquake landslide inventory (Massey et al., 2020), to the extent of the OFD zone and ground motion attenuation models published for the Kaikōura earthquake. In the absence of constraints on coseismic ground motions close to faults, we cannot separate the effects of decreased rock mass strength from enhanced shaking associated with trapped seismic waves or lithologic contrasts. However, using the OFD zone, we can compare the landslide density response to (1) "rock mass damage effects," including both locally enhanced ground motions and decreased rock mass strength, and (2) the attenuation of ground motions, which appears to influence landslide occurrence further from faults.

2016 KAIKOURA EARTHQUAKE AND COSEISMIC LANDSLIDES

The 2016 Mw 7.8 Kaikōura earthquake initiated on the Humps fault (Fig. 1). The rupture propagated to the northeast, across slow-slip-rate (~1 mm/yr) faults of the North Canterbury Domain (NCD) and onto the faults of the Marlborough fault system (MFS; Hamling et al., 2017; Litchfield et al., 2018), which have much higher slip rates (up to ~25 mm/yr).

During the 2016 event, surface ruptures were observed on 20 onshore and offshore faults with a range of orientations and relative motions (Fig. 1; Litchfield et al., 2018; Zinke et al., 2019). The greatest surface slip occurred on the Papatea, Jordan, and Kekerengu faults in the MFS (up to 12 m lateral and 8 m vertical); other MFS faults with documented surface rupture include the Manakau, Upper Kowhai, and Snowflake Spur faults in the Seaward Kaikōura range (Fig. 1; Litchfield et al., 2018; Zinke et al., 2019). In the NCD south of the Hope fault, the Humps, Leader, Conway-Charwell, Stone Jug, Hundalee, and Whites faults ruptured to the surface (Fig. 1; Litchfield et al., 2018). Slip on NCD faults was lower (up to ~3.5 m vertical and lateral) than slip on MFS faults.

The Kaikōura earthquake triggered nearly 30,000 landslides over an ~10,000 km2 area. Approximately 60% of failures occurred on the steep slopes of the Seaward Kaikōura Range (Fig. 1), which is composed of pervasively fractured Early Cretaceous graywacke sandstones and mudstones of the Pahau terrane of the Torlesse Supergroup (Rattenbury et al., 2006). Elsewhere, landslides were concentrated within Late Cretaceous–age to Tertiary-age sedimentary units and unconsolidated Quaternary units (Rattenbury et al., 2006). No direct landslide-related fatalities were recorded from the event, but landslides formed 196 dams and blocked arterial roads and railways for months (Dellow et al., 2017).

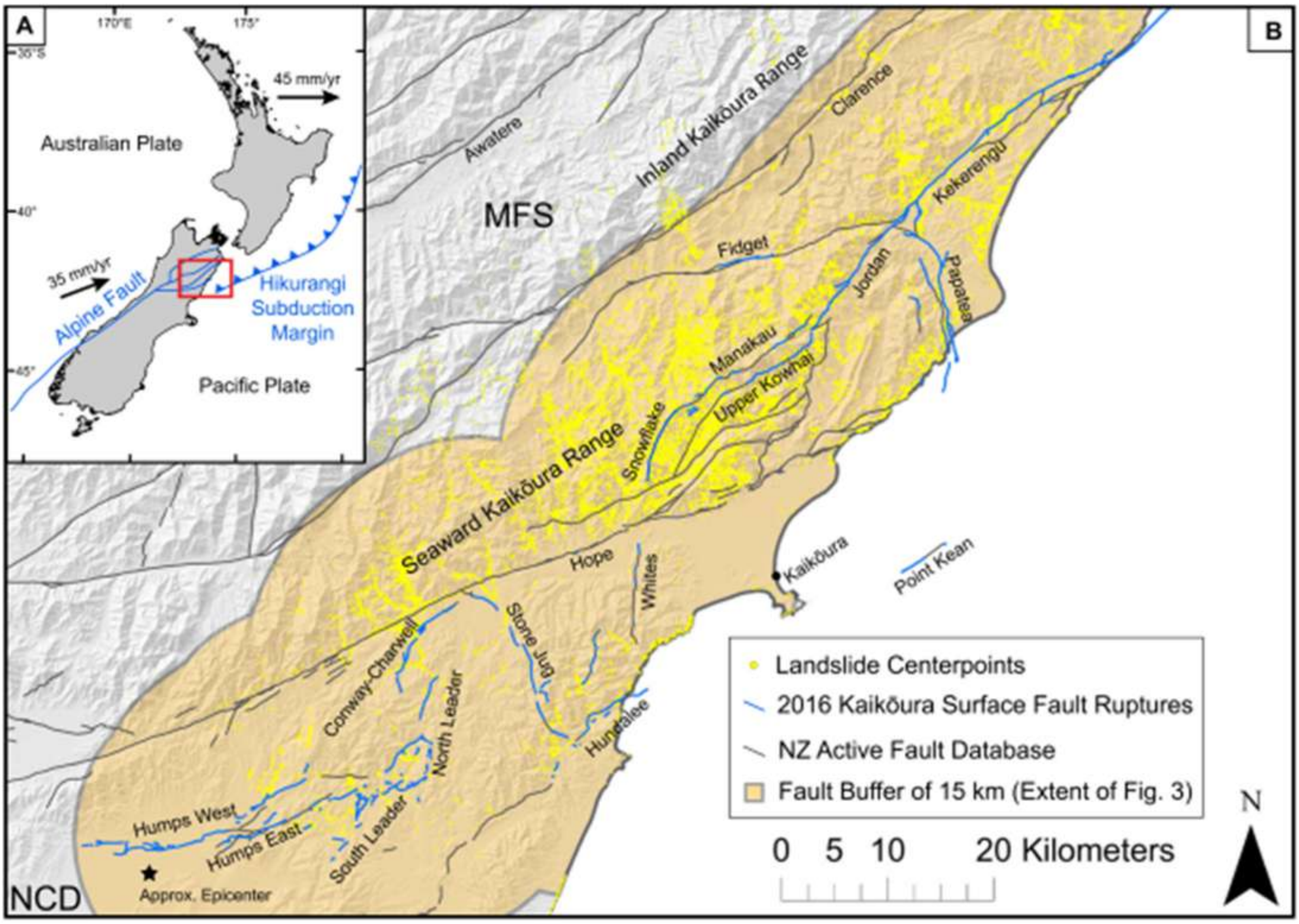

Figure 1. (A) Major tectonic structures in New Zealand (blue) and relative motion of the Australian and Pacific plates (black arrows; Beavan et al., 2002). (B) Surface fault ruptures from the 2016 Mw 7.8 Kaikōura earthquake (blue) and active faults in the New Zealand Active Fault Database (gray) that did not rupture to the surface in 2016 (Langridge et al., 2016). Yellow points are source area center points for coseismic landslides triggered by the 2016 earthquake (Massey et al., 2020). Orange shaded area is the extent of analysis shown in Figure 3. The Marlborough fault system (MFS) lies north of the Hope fault, while the North Canterbury Domain (NCD) lies south.

Logistic regression models suggested that, in order of importance, the independently tested parameters of geology, mean slope, distance to surface fault rupture ("distance to fault"), local slope relief, peak ground velocity, and mean elevation contributed significantly to the locations of landslides during the Kaikōura event (Massey et al., 2020). The "distance to fault" variable is the third most important and the least understood parameter.

OFF-FAULT DEFORMATION (OFD) ZONE WIDTH

We measured three-dimensional surface displacements over a 25 m grid using point cloud data generated from pre– and post–Kaikōura earthquake optical aerial imagery and a 50 × 50 m windowed implementation of the iterative closest point algorithm (Diederichs et al., 2019; Howell et al., 2020). Using the displacement field, we mapped simplified "main" fault traces for 14 major surface ruptures, which generally coincided with previously mapped traces (e.g., Litchfield et al., 2018; Zinke et al., 2019). Swath profiles 400 m wide and 2 km long, oriented perpendicular to local fault strike, were centered along the fault traces at 500 m intervals. For each swath, we produced separate displacement profiles in each of the east, north, and vertical components. We removed noise from identifiable sources (e.g., landslides, fast-growing trees) manually and excluded sites from our analysis where we were unable to resolve displacements due to excessive noise. The width of distributed coseismic displacement around the fault was visually estimated for each displacement component profile as the point on either side of the fault at which the displacement field settled into the background total displacement (Milliner et al., 2016; Zinke et al., 2019). At each site, the component exhibiting the widest distribution of displacement across the fault was used to define the total extent of coseismic OFD within the swath profile (Fig. 2A). As a conservative estimate of the OFD zone between profiles, we then connected profile swaths on individual faults using straight lines between adjacent profiles (Fig. 2B). The resulting variable-width polygon defined the widest area of on-fault permanent coseismic strain around the 2016 surface ruptures.

In total, we estimated the OFD zone at 214 locations across 14 primary surface ruptures (Fig. 2C). Surface ruptures in the northern MFS region (Kekerengu, Jordan, Papatea, Upper Kowhai, Manakau, and Snowflake) exhibited an average OFD width of ~500 m, compared with ~600 m for faults in the southern NCD region (Whites, Stone Jug, Conway-Charwell, Leader, Humps, and Hundalee). OFD widths ranged from ~50 m to ~1500 m and did not approach the 2 km length of the profile swath in any location.

The OFD zone was locally variable across the components of displacement and along fault traces. This variability likely resulted from factors including lithology and thickness of any

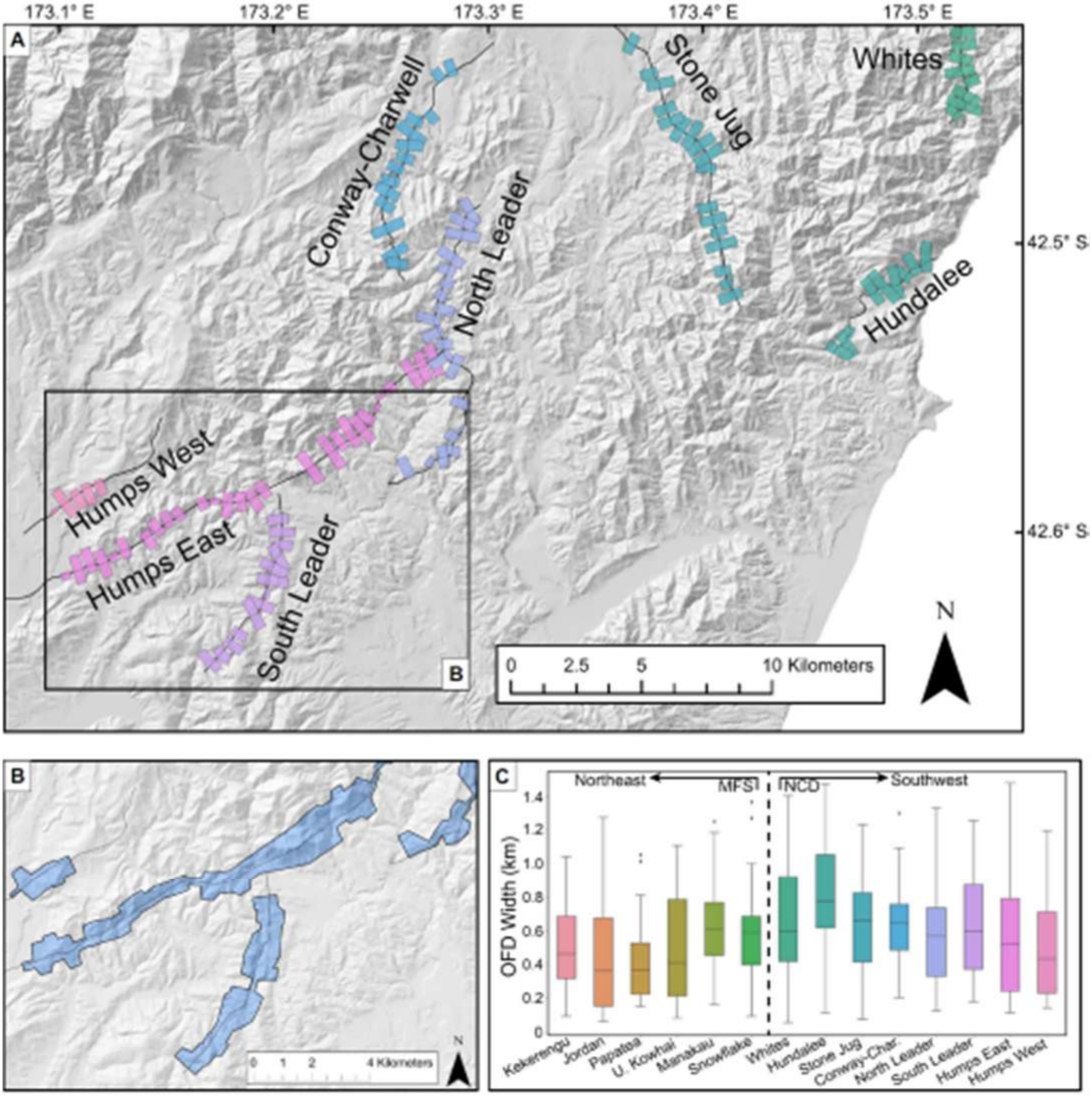

Figure 2. (A) Fault ruptures and estimated widths of off-fault deformation (OFD) for the North Canterbury Domain (NCD) on the South Island of New Zealand. (B) Example of the OFD zone interpolated between measured swaths for the Humps and South Leader faults. (C) Box and whisker plots showing OFD width distributions by fault from northeast to southwest. Colors are coordinated with panel A. MFS—Marlborough fault system.

overlying sediment, near-surface fault geometry and kinematic variability along strike, slip partitioning over several fault strands, and interaction between faults at depth (Zinke et al., 2014).

LANDSLIDE DENSITY AND FAULT DISTANCE

We used a 32 m gridded version of the 2016 Kaikōura coseismic landslide inventory (Massey et al., 2020) to calculate landslide source area density within OFD zones and regularly spaced (50 and 200 m increments out to 15 km) buffers around surface fault ruptures in the Kaikōura region (Fig. 3).

There was a gradual decrease in landslide density from 1.6% at 1000 m to 0.3% at 15,000 m (1.3% decrease over 14 km), which mirrored the attenuation of observed and modeled horizontal peak ground accelerations (PGAs, from a hybrid broadband ground motion simulation; Bradley et al., 2017) with increasing distance from the fault (Fig. 3A). However, we observed a sharp increase in landslide source area density from 1.6% at 1000 m to 3.3% at 150 m (1.7% increase over 1 km; Figs. 3A and 3B). This increase in landslide density did not correlate with any marked increase in slope (Fig. 3C), local slope relief (Fig. S7 in the Supplemental Material1), or modeled PGA (Fig. 3A; Bradley et al., 2017) within 1000 m of surface-rupturing faults, but it could still have resulted from nonlinear attenuation not captured by modeled PGA or a different frequency content of shaking near the faults.

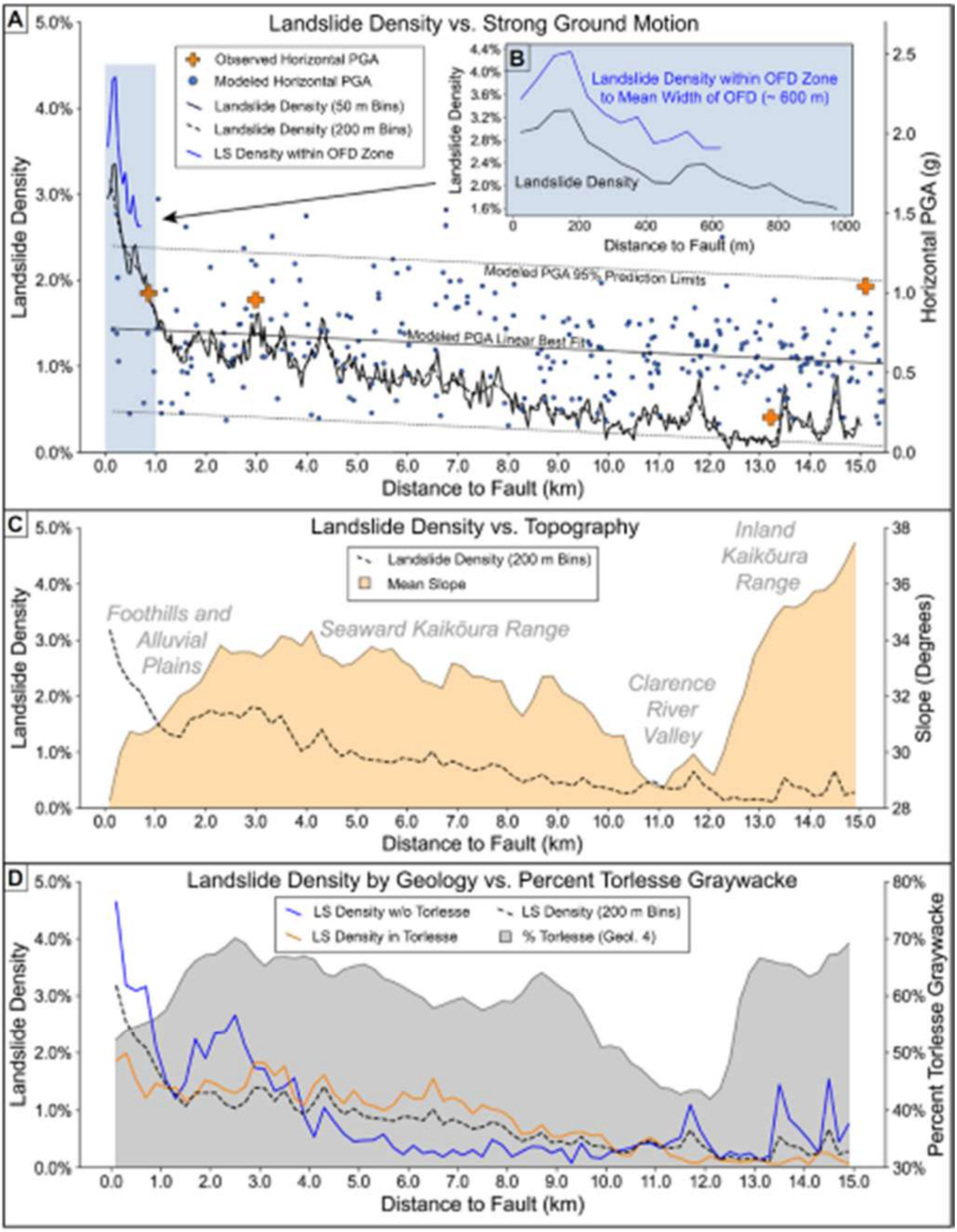

Figure 3. Landslide density for the 2016 Kaikōura earthquake (South Island, New Zealand). (A) Landslide density (percent of area covered by landslide source) and horizontal peak ground acceleration (PGA) (Bradley et al., 2017) relative to fault distance. Solid black line represents 50 m bins of fault distance from 0 m to 15,000 m (i.e., 0–50 m, 50–100 m, etc.); dashed black line represents 200 m bins of fault distance; and blue line represents 50 m bins of fault distance exclusively within the off-fault deformation (OFD) zone to 650 m. (B) Zoomed-in view of panel A from 0 m to 1000 m. (C) Graph of landslide density and mean slope (orange) relative to fault distance in 200 m bins. Major topographic features contributing to the distribution of slope with distance from the fault are labeled. (D) Graph of general landslide (LS) density (dashed black line), landslide density within the Torlesse Supergroup graywacke (orange line), and landslide density within all other geologic units (blue line) relative to fault distance.

The rupture of more than 20 faults over ~180 km made it difficult to assess nonlinear landslide attenuation relationships from the hypocenter for the Kaikōura earthquake (Meunier et al., 2007). However, the modeled PGAs matched well with limited observational ground motion records and represent the current best estimate of near-fault ground motion from the 2016 Kaikōura event. Modeling approaches may never fully capture the true magnitude, frequency, or heterogeneity of near-fault shaking unless they explicitly account for the effects of near-fault rock damage. However, the modeling approach used by Bradley et al. (2017) has actually overestimated fault-proximal (<2 km distance) PGA and peak ground velocity (PGV) where limited records were available (Graves and Pitarka, 2010). Thus, the results suggest that two of the most important influences on slope stability—local slope and PGA—did not exert primary influences on regional landslide densities within 1 km of the fault (Figs. 3A and 3C).

Lithology may partially explain the increase in landslide density with proximity to the fault. In the Kaikōura region, active faults commonly form the contacts between Tertiary "soft rocks," range-front Quaternary units, and Torlesse Supergroup graywacke (Rattenbury et al., 2006). As a result, while ~70% of the Kaikōura region consists of Torlesse graywacke at the surface, graywacke constitutes a lesser ~55% of surface area near ruptured faults (Fig. 3D). The younger units exhibited much higher landslide density near the fault than did the graywacke bedrock (Fig. 3D). This phenomenon, which may result from amplification due to basin-edge effects (Graves et al., 1998) and impedance contrasts between lithologies, could factor into general "distance to fault" trends here (Fig. 3) and in other earthquakes (e.g., Rault et al., 2019).

INCREASED LANDSLIDE DENSITY WITHIN OFD ZONES

Our results reveal a consistently higher landslide density for individual fault buffers nested within the OFD zone as compared to general distance from fault (Figs. 3A and 3B). The higher density extended up to ~650 m from the faults and indicates that more landslide terrain is located in the OFD zone per unit area despite a relatively representative distribution of topography (Fig. S6). Though it is difficult to decouple the effects of the OFD zone from the influence of lithologic contrasts, the higher density of landslides in the OFD zone does not appear to be biased by lithology. The OFD zone captures a representative proportion of lithologies and has a higher overall landslide density in both Torlesse and non–Torlesse Supergroup lithologies (Table S1; Fig. S8). Other physical influences like instantaneous (i.e., coseismic) or finite strain, coupled with seismic amplification within the weaker rock mass of the fault damage zone itself, could contribute to the higher incidence of landslides close to faults.

Future fault zone studies may provide a way to decouple the near-fault processes and factors that link OFD to near-fault damage and increased coseismic landslide occurrence. In the near term, however, the observed correlation between the OFD zone and increased coseismic landslide occurrence may, itself, be sufficient to improve landslide susceptibility models.

POSSIBLE IMPROVEMENT ON THE "DISTANCE TO FAULT" PARAMETER

The OFD zone captures a higher incidence of landslides near the fault than is readily explained by "distance to fault" or modeled ground motion attenuation alone. Separate variables for modeled ground motion attenuation and fault zone width could serve as a more robust replacement for the "distance to fault" parameter. Together, these two variables are more likely to capture both the near- and far-field attenuation of ground motion and also account for other near-fault factors like decreased rock mass strength. Even general estimates of fault zone width, from field mapping or geophysical surveys, could be an effective tool for approximating the spatial extent of enhanced coseismic landslide susceptibility near faults. Further statistical and field investigations are necessary to fully evaluate the influence of the OFD zone on susceptibility models; nevertheless, characterization of this zone serves as a novel path toward improving our understanding of coseismic landslides.

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Νέα σεισμοτεκτονικά προβλήματα και αμφισβητήσεις από τους σεισμούς της Βόρειας Θεσσαλίας 2021

Σπύρος Παυλίδης και Σωτήριος Σπόρας

Είναι γνωστό στην γεωεπιστημονική κοινότητα ότι κάθε σεισμός με την ιδιαίτερη «προσωπικότητα» του και τη μοναδικότητα του προσφέρει νέα δεδομένα, γνώσεις και νέους προβληματισμούς. Οι σεισμοί της $3^{ης}$ και $4^{ης}$ Μαρτίου 2021 (M_w6.3 και M_w6.0), στη Βόρεια Θεσσαλία (Δαμάσι - Τύρναβος) εγείρουν νέα ερωτήματα και αναθεωρούν ορισμένες καθιερωμένες απόψεις μας, όπως: Άγνωστο κανονικό «κρυφό» ή «τυφλό» ρήγμα, μικρής γωνίας κλίσης, διαφορετικής διεύθυνσης, σε πεδίο τάσεων που αποκλίνει από το καθορισμένο ενεργό, προβλήματα στην εκτίμηση της σεισμικής επικινδυνότητας.

1. Οι σεισμοί συνέβησαν σε άγνωστο και μη χαρτογραφημένο σεισμικό ρήγμα ΒΒΔ-ΝΝΑ διεύθυνσης στον ορεινό όγκο Αντιχάσια και μάλιστα σε παλαιοζωικά πετρώματα της Πελαγονικής γεωτεκτονικής ζώνης.

2. Το σεισμογόνο ρήγμα έχει μικρή γωνία κλίσης 36° με 40° στα όρια μηχανικής θραύσης.

3. Οι εργασίες υπαίθρου, τα σεισμολογικά δεδομένα και η δορυφορική Συμβολομετρία δείχνουν ότι ούτε το πολύ καλά μελετημένο ενεργό ρήγμα Τυρνάβου στην επικεντρική περιοχή, ούτε η προέκταση προς ΒΔ του γνωστού ρήγματος της Λάρισας (ή ρήγμα Τιταρήσιου), δεν δημιούργησαν το κύριο σεισμικό γεγονός, αν και φαίνεται ότι έχουν επηρεαστεί ή ενεργοποιηθεί εν μέρει από το κύριο σεισμικό ρήγμα ως δευτερεύουσες ("συμπαθητικές") δομές.

4. Σε ό, τι αφορά το άγνωστο και μη χαρτογραφημένο σεισμικό ρήγμα, η επιτόπια έρευνα έδειξε ότι υπάρχουν χαρακτηριστικές γεωλογικές ενδείξεις στο υπόβαθρο, που αποτελείται από μεταμορφωμένα πετρώματα, όπως μαρμαρυγιακούς σχιστόλιθους και γνεύσιους, υποδεικνύοντας ότι ένα κανονικό ρήγμα έχει λειτουργήσει ως κρυφό ή τυφλό κατά τη διάρκεια του σεισμού. Συνδέεται με μεταλπικές ζώνες διάτμησης, με τη σχιστότητα και με ζώνες κατακλασίτη των πετρωμάτων του υποβάθρου, καθώς και με μικρά ανάστροφα ρήγματα της πελαγονικής αντικλινικής δομής. Το σεισμικό ρήγμα εκτείνεται στην ευρύτερη περιοχή μεταξύ των χωριών Ζάρκο και Μεγάλο Ελευθεροχώρι, ως κληρονομημένη αλπική ζώνη διάτμησης, πιθανώς δομή αποκόλλησης(αντίστροφη τεκτονική).

5. Το ενεργό πεδίο των τάσεων του ανώτερου φλοιού της περιοχής έχει υπολογιστεί ως εκτατική (εφελκυστική) τάση ΒΒΑ-ΝΝΔ διεύθυνσης (σ_3 ή T), τόσο με νεοτεκτονικές ποσοτικές μεθόδους της τεταρτογενούς ηλικίας, όσο και με εστιακούς μηχανισμούς πρόσφατων σεισμών, ενώ του παλαιότερου πεδίου Νεογενούς – Πλειοκαίνου είχε διαφορετική διεύθυνση εφελκυσμού ΒΑ-ΝΔ (σ_3). Η κατάσταση των τάσεων ενεργού στρες και η κατεύθυνση των ενεργών τεκτονικών δομών φαίνεται ότι δεν είναι αποκλειστικά η καθιερωμένη. Οι μηχανισμοί γένεσης των πρόσφατων σεισμών δείχνουν τη διεύθυνση του παλαιότερου πεδίου τάσεων.

6. Ταυτόχρονα, ωστόσο, εγείρονται νέες ανησυχίες και ουσιώδη ερωτήματα, όπως η ύπαρξη σεισμογόνου ρήγματος σε ορεινό όγκο κρυσταλλικών πετρωμάτων, χωρίς τυπική γεωμορφολογική έκφραση και άρα μη αναγνωρίσιμο και ο ρόλος των τυφλών ρηγμάτων στην εκτίμηση της σεισμικής επικινδυνότητας.

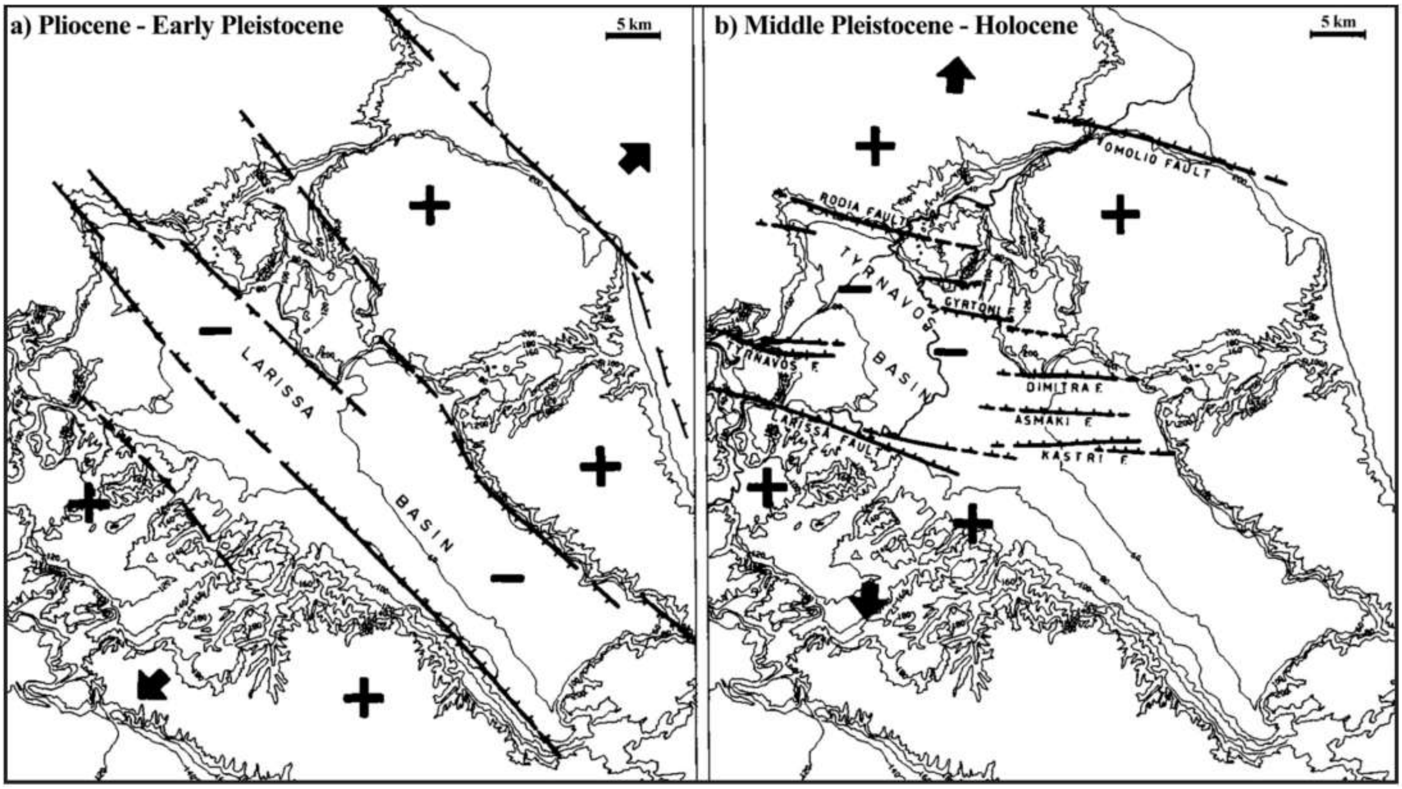

Figure 3. Simplified structural map of eastern Thessaly showing the major normal faults activated during the Pliocene-Lower Pleistocene (a) and Middle Pleistocene – Holocene (b) extensional regime. Arrows point the direction of the extensional stress field. "+" and "-" signs represent uplifted and depressed areas. After Caputo et al. (1994) (από το άρθρο Pavlides, Spyros and Sotiris Sboras (2021). **Recent earthquake activity of March 2021 in northern Thessaly unlocks new scepticism on Faults.** Turkish J Earth Sci, 30, (2021), 851-861 DOI: 10.3906/yer-9-2110)

Οι διαρκώς αυξανόμενες νέες γνώσεις από την επιστημονική κοινότητα παγκοσμίως και τα νέα προβλήματα απαιτούν ορθολογικές απαντήσεις, όπως:

Πότε, πού και πόσο παλιές γεωτεκτονικές δομές, με διάφορους προσανατολισμούς στο σύγχρονο πεδίο τάσεων, μπορούν να δραστηριοποιηθούν; Πώς διαδίδεται η διάρρηξη; Τόσο οριζόντια όσο και προς την επιφάνεια, και πώς επηρεάζει γειτονικά νέα και «ανενεργά» γεωλογικά ρήγματα ενεργοποιώντας παλιές κληρονομικές τεκτονικές δομές; Πώς επηρεάζεται η μορφολογία, ή που δραστηριοποιούνται σεισμικά ή ασεισμικά ρήγματα κατά μήκος των περιθωρίων εμφανών γεωμορφολογικών λεκανών και γιατί συμβαίνουν σπάνια αλλά απροσδόκητα σε τοποθεσίες όπως είναι οι ορεινές περιοχές;

Ποιές είναι οι καλύτερες αυτόνομες ή συνδυασμένες μέθοδοι ανίχνευσης και αναγνώρισης τεκτονικών δομών ή ζώνες ευαισθησίας του φλοιού, καλά κρυμμένες, είτε από φυσικές διαδικασίες (καλύμματα ιζημάτων) ή από ανθρώπινες παρεμβάσεις;

Οποιαδήποτε απάντηση στα παραπάνω ερωτήματα μπορεί να είναι καθοριστικής σημασίας και να συμβάλλουν σε μια ουσιαστική εκτίμηση της σεισμικής επικινδυνότητας: όπως η προσομοίωση κίνησης σε έδαφος πάνω από άγνωστο ρήγμα (ντετερμινιστική σεισμική εκτίμηση επικινδυνότητας (DSHA), η δόμηση παρά τα ρήγματα χωρίς επιφανειακή γεωλογική έκφραση, κρίσιμες εκτιμήσεις για σχεδιασμό κτιρίων και υποδομών, λαμβάνοντας υπόψη ότι μια πιθανή επιφανειακή μετατόπιση ρήγματος θα μπορούσε να καταστρέψει τα θεμέλια οποιασδήποτε τεχνικής κατασκευής. Η εκτίμηση των κινδύνων είναι ζωτικής σημασίας για μέρη όπου ο σεισμικός κίνδυνος είναι υψηλός, όπως σε κρίσιμες εγκαταστάσεις ή/και στις σύγχρονες αστικές περιοχές, πολεοδομικές επεκτάσεις, δίκτυα κ.α. Ως εκ τούτου, χρειάζεται να δοθεί προσοχή στον ρόλο των κληρονομημένων δομών στη σεισμογένεση, που αποκλίνουν από τους καθιερωμένους κανόνες, ειδικά τα τυφλά ρήγματα σε βουνά χωρίς κανένα μορφοτεκτονικό ή άλλο γεωλογικό –γεωφυσικό γνώρισμα. Απαιτούνται νέες μεθοδολογίες και κατάλληλα επιστημονικά εργαλεία για καλύτερη προσέγγιση και λύση των πολύπλοκων προβλημάτων.

Σχετική βιβλιογραφία

Pavlides, Spyros and Sotiris Sboras (2021). **Recent earthquake activity of March 2021 in northern Thessaly unlocks new scepticism on Faults.** Turkish J Earth Sci, 30, (2021), 851-861 DOI: 10.3906/yer-9-2110

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Το παραπάνω κείμενο αποτελεί περίληψη του πρώτου άρθρου της σχετικής βιβλιογραφίας, που έγινε από τον πρώτο συγγραφέα. Λεπτομέρειες για το άρθρο παρακάτω:

Recent earthquake activity of March 2021 in northern Thessaly unlocks new scepticism on Faults

Spyros B. PAVLIDES, Sotirios P. SBORAS

Abstract

This short opinion article presents and highlights new and old problems related to active geological faults, as seismic sources, after the experience of the last March 3 and 4, 2021 (Mw6.3 and Mw6.0, respectively) Tyrnavos-Elassona earthquakes in northern Thessaly, Greece. Although the active faults in the area are very well studied, demonstrating typical geomorphic features that intensely affect the morphological relief, it seems that the earthquakes were produced by unknown faults emerging in the mountainous area (alpine basement). Primary (?) coseismic ruptures, however, were also observed northwards along the Titarissios valley. A geological interpretation of the faulting mechanism is also proposed. The existence of a new unknown source in an intermontane area is problematic. The role of inherited alpine structures seems more important today than in the past. The strike of the two new seismogenic sources, responsible for the two strongest events of the 2021 earthquake succession, differs from the previously known active faults. This forces us to reconsider older views on the direction of development of active faults and the orientation of the stress field. Concerns are being raised about how new structures can be detected and their role in seismic hazard assessment, especially when located near or within the urban fabric, in cities that are now constantly expanding and being established in new, often loose soils.

Pavlides, Spyros and Sotiris Sboras (2021). **Recent earthquake activity of March 2021 in northern Thessaly unlocks new scepticism on Faults.** Turkish J Earth Sci, 30, (2021), 851-861 DOI: 10.3906/yer-9-2110

Active Tectonics and Seismicity of the Aegean Region with special emphasis on the Samos Earthquake struck on 30 October 2020

Guest Editors
Spyros PAVLIDES, Riccardo CAPUTO, Hasan SÖZBİLİR

CONTENTS

Active Tectonics and Seismicity of the Aegean Region with special emphasis on the Samos Earthquake struck on 30 October 2020

Guest Editors: Spyros PAVLIDES, Riccardo CAPUTO, and Hasan SÖZBİLİR

Preface

The earthquake of Mw 6.9 magnitude that occurred on the 30th of October, 2020 in Kuşadası Bay on a fault along the northern coast of Samos Island is among the few major earthquakes that have affected this sector of the Aegean Region during the last century. Unfortunately, it has caused great loss of lives and damages in residential areas of the Samos Island and as far as in the city of İzmir. On the other hand, many devastating earthquakes were recorded in both countries facing the Aegean Sea, causing loss of life and property in instrumental and historical periods. This is well documented by a huge literature with countless papers based on specific and regional studies carried out on several seismogenic sources and associated earthquakes occurring in the broader Aegean Region between the Hellenic Arc and the North Anatolian Fault. From a geological and geodynamic point of view, this area represents a unique natural laboratory for investigating seismotectonics, making it of global scientific interest due to its intense seismic activity.

Considering the international interest risen by the damages both in İzmir on the Turkish side and on the Samos Island on the Greek side, a Workshop on "Active Tectonics and Seismicity of the Aegean Region with special emphasis on the October 30, 2020 Samos Earthquake (ASASE2021)" was organized online on May 20–21, 2021 under the leadership of TÜBİTAK and with the contributions of Dokuz Eylül University, Sivas Cumhuriyet University, the Aristotle University of Thessaloniki, and the University of Ferrara. The aim was to share and discuss the information that was already available at that time from numerous researchers but also to inform the public. Indeed, the most important action we, as earth scientists, could put forward against earthquakes is the production of scientific data, based on a collaborative approach and common goals. Although focusing on the effects of the Samos earthquake observed within the broader Aegean Region, the workshop represented an important occasion to discuss earthquake phenomena in general and to shed light on the active tectonics and seismicity of the area. A total of thirty oral and five poster presentations were presented by scientists from Turkey, Greece, Italy, Germany, Japan, Canada, and the United States of America during the two-day workshop. In these presentations, the latest scientific studies on earthquake geology and the seismicity of the Aegean Region, earthquake hazard sources, and tsunami hazards were presented and discussed among all scientists participating at the workshop. Updated data obtained on both the land side and the sea by the scientists were presented under a wide range of topics, investigation tools, and methodological approaches such as active tectonics, geodynamics, seismic, tsunami, Global Positioning System (GPS), and Interferometric Synthetic Aperture Radar (InSAR) applications. The aforementioned issues reveal the importance of multidisciplinary and international research for better understanding and modeling active tectonics and Seismic Hazard Assessment based on the high-resolution data obtained by field studies, as well as by theoretical approaches.

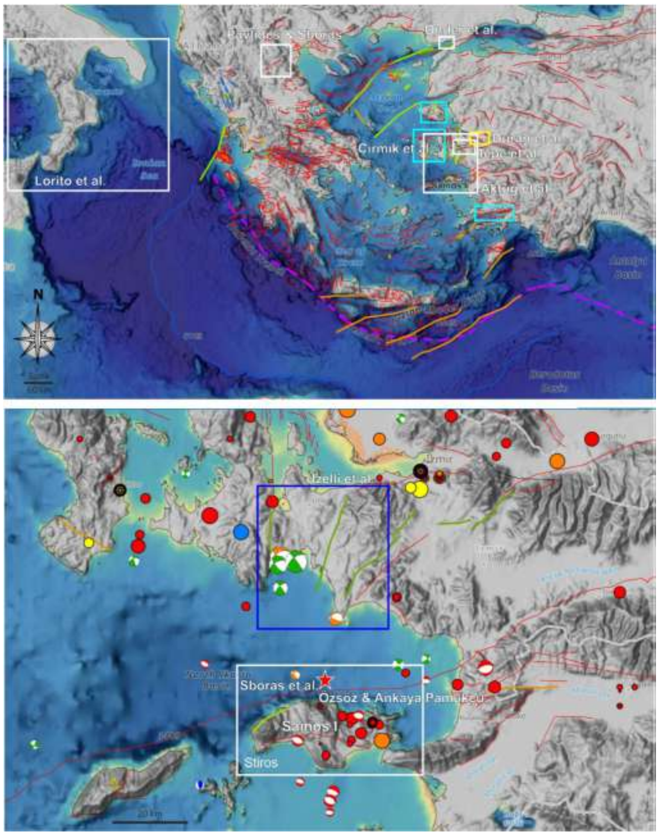

Figure. Seismotectonic map of the West Anatolia and the broader Aegean Region. The areas described in this special issue are also indicated in boxes. Base maps are from the Greek and Turkish Seismotectonic Database.

We would like to emphasize that every new scientific knowledge becomes more valuable when shared, and new opportunities are obtained to create an impact within a collaborative approach in the field of earthquake research. This workshop also created a scientific bridge between scientists for dealing with natural disasters and especially the seismic activities that affect a wide region of the Eastern Mediterranean. This bridge that we have built must be strengthened with future collaborations.

In this Special Issue of the Turkish Journal of Earth Sciences, the following contributions have been selected from the workshop presentations after peer-review process (see Figure).

Source modelling and stress transfer scenarios of the October 30, 2020 Samos earthquake and its seismotectonic implications studied by **Sboras et.al. (2021)** by using seismological and geodetic data (GPS measurements and originally processed GNSS records), as well as their field observations on Samos Island few days after the mainshock. The integration of this information leads to a N-dipping normal fault (Kaystrios fault) that controls the central-northern coast of Samos Island. They modelled the seismic source and calculated the theoretical dislocation (using the Okada formulae) on the surrounding GPS/GNSS stations, comparing it with the measured values. They also studied the spatiotemporal evolution of the aftershock sequence by exploiting published seismological data (focal mechanisms and two seismic catalogues, one of which with relocated hypocentres) and calculated Coulomb static stress changes caused by the mainshock. This comparison suggests that more faults than the Kaystrios fault were involved in the aftershock sequence and that the Coulomb stress changes indicated various results according to each receiver fault. In the study by **Aktuğ et al. (2021)**, the finite source mechanism of the Samos earthquake was investigated using geodetic methods and the coseismic behavior of the earthquake was modeled. To determine the coseismic displacements, GNSS measurements were carried out at 62 sites. The maximum coseismic displacement was calculated -372 mm and 65.3 mm for the N and E component, respectively. The displacements at 62 sites were inverted for the fault geometry and the slips. The uniform slip modeling shows a finite source 43.1 km long and 16 km wide rupture, with 1.42 m of dip-slip kinematics along a north dipping normal fault extending from the Aegean Sea floor to a depth down to ~13 km. The **Stiros (2021)** contribution is an effort to explain macroseismic results and to join with seismic accelerations (strong motion), a serious and difficult subject. The author addresses it and by studying overturned ancient columns on Samos Island estimates a minimum ground acceleration, as well as some likely spectral frequencies concluding that though earthquakes similar to the 2020 Samos event are not uncommon, modelling of ancient earthquakes based on very limited historical information needs to be revisited. As such work is in principle useful particularly after the destructive Samos-Izmir earthquake of 30 October 2020. Detection and interpretation of precursory magnetic signals preceding the October 30, 2020 Samos event was studied by **Özsöz and Ankaya Pamukçu (2021).** They analysed swarm satellite magnetic data for 153 days before and 46 days after the earthquake. Pre-event and post-event anomaly search is constrained within the Dobrovolsky's Circular Area. They made 5 steps for processing satellite magnetic data to interpret the earthquake preparation phase. In the first step, they converted geographical coordinates into geomagnetic latitude and longitude. Secondly, intensity of the external magnetic field was evaluated by magnetic indices. Thirdly, preearthquake and postearthquake magnetic anomaly was constrained through magnetic indices and Dobrovolsky's Circular Area. The fourth step was the filtering shortwavelength magnetic anomalies using first time derivative and trend removal (detrend), while during the last step anomalous residual magnetic variations of the satellite tracks were classified through RMS analysis. The cumulative number of anomalous points (y-axis) is plotted versus the date (x-axis). R2 values denote the degree of linear distribution of the anomalous tracks. For X, Y, Z, and F components of the magnetic field, R2 is computed as 0.90 0.87, 0.85, and 0.97, respectively. According to the authors, Y component of the magnetic field provided the best results in terms of interpretation. Regarding the results of the Y component, linear distribution and deviation from this distribution are fairly distinguishable. Water resources were monitored by **Uzelli et al.**

(2021) in the areas of Bayraklı, Gülbahçe, and Seferihisar before the October 30, 2020 Samos earthquake. Especially, the water level rise steps observed in ten shallow wells in Bayraklı Plain are due to the compaction of the units during the earthquake. It is a significant finding that the instantaneous changes in the temperature, electrical conductivity, and groundwater level in the observation wells were determined at the time of and before the earthquake. In addition to causing sudden changes in groundwater levels, observations show that the seismic activity can keep water levels under control for a certain period. As in groundwater, the Samos earthquake also showed its effect on nearby fault zones. Faults in the Seferihisar and Gülbahçe geothermal fields were affected by the Samos earthquake, and formation new geothermal springs, gas leakage and liquefaction events were detected in these areas. Also, temperature and flow rate increases, especially in geothermal waters after the Samos earthquake, are quite remarkable. As a result, the formation of new geothermal springs on known fault segments (Gülbahçe-İçmeler and Tuzla Faults) and groundwater level changes in Bayraklı Plain are situations that should be carefully monitored in the long term.

The **Tepe et al. (2021)** paper is a remarkable attempt to further compile an updated historical earthquake catalog for the Izmir area using more than 20 earthquake catalogs, many of which have never been used in previous studies. Furthermore, they correlation historical earthquakes with seismic sources have the potential to produce destructive earthquakes. As such, it is in principle useful particularly after the destructive Samos event of 30 October 2020. **Duran et.al. (2021)** studied the palaeoseismic history of the Manisa fault zone (MFZ), which constitutes the western section of the Gediz Graben. According to the results obtained from the trenches, they detected six surface rupturing earthquakes since late Pleistocene-Holocene, which have occurred at 30.6 ± 8.8 ka (E1), 15.0 ± 5.0 ka (E2), 6.6 ± 1.3 ka (E3), 2.9 ± 1.3 ka (E4), 0.8 ± 0.4 ka (E5), and 0.1 ± 0.1 ka (E6) and can be correlated with 17 AD, 926 AD, and 1962 AD. The proposed interevent time, the estimation of the recurrence interval for the MFZ, varied between 0.95 ka and 3.8 ka for the Holocene, and the elapsed time since the most recent surface ruptured earthquake on the MFZ is 159 years. **Pamukçu et al. (2021)** provide detailed data on the seismic a and b-values within the first 24 hours and 14 days after the mainshock of Chios Island-Gokova Bay (Mw= 6.6), Lesvos Island-Karaburun (Izmir) (Mw=6.2) and Samos Island-Aegean Sea (Mw=6.9) earthquakes. The a and b values were found as 4.13 and 0.59 for the Samos Island-Aegean Sea earthquake, 4.20 and 0.81 for the Lesvos Island-Karaburun (Izmir) earthquake, 4.66 and 0.84 for the Chios Island-Gokova Bay earthquake aftershocks in 24 hours. The a-value and b values were calculated as 4.88 and 0.74 for the Samos Island-Aegean Sea, 4.77 and 0.87 for the Lesvos Island-Karaburun (Izmir) earthquake, 4.96 and 0.87 for the Chios Island-Gokova Bay earthquake and its aftershocks in 14 days. They found that there is a crustal problem at the lower crust of Samos Island and its surroundings, also the lower crusts of the regions including Lesvos and Chios Islands are stronger than the regions including Samos Island.

Recent earthquake activity in March 2021 in northern Thessaly is the subject of **Pavlides and Sboras (2021)** presentation. In this short opinion study, the authors aim to present new and old problems related to active faults as seismic sources, after the last March 3 and 4, 2021, (Mw = 6.3 and Mw = 6.0, respectively) earthquakes in Northern Thessaly, Greece. They suggest two new seismogenic sources responsible for the two strongest geological events of the 2021 earthquake succession, which differ from the previously known active faults indicating the role of inherited Alpine structures that seem more important today than in the past. Fault-controlled gas escapes in the shelf sediments of the Saros Gulf, NE Aegean Sea is described by **Önder et al. (2021).** They performed high-resolution seismic profiles along the submarine Ganos Fault, in the Saros Gulf and use the obtained results to better constrain the main fault segments affecting the area providing important information on this seismogenic structure. The survey also allowed to identify features on the seabed associated with the expulsion of hydrocarbon gases and fluids. According to the authors, understanding these interactions may provide valuable contributions to hydrocarbon explorations and early-warning strategies against earthquake risk.

Lorito et al. (2021) give an overview regarding tsunami hazard, warning, and risk reduction in Italy and the Mediterranean Sea. They describe the status quo of the tsunami hazard management by CAT-INGV and the other national agencies involved. The topics dealt with range from operational, organizational, and legal aspects of the earthquake and tsunami monitoring, to local hazard assessment, planning, awareness-raising and preparation, within an end-to-end excursus. They also describe the gaps and issues that need to be taken into account, as well as plans and strategies to tackle them.

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https://journals.tubitak.gov.tr/earth/issue.htm?id=7361

Probabilistic, high-resolution tsunami predictions in northern Cascadia by exploiting sequential design for efficient emulation

Dimitra M. Salmanidou, Joakim Beck, Peter Pazak, and Serge Guillas

Abstract

The potential of a full-margin rupture along the Cascadia subduction zone poses a significant threat over a populous region of North America. Previous probabilistic tsunami hazard assessment studies produced hazard curves based on simulated predictions of tsunami waves, either at low resolution or at high resolution for a local area or under limited ranges of scenarios or at a high computational cost to generate hundreds of scenarios at high resolution. We use the graphics processing unit (GPU)-accelerated tsunami simulator VOLNA-OP2 with a detailed representation of topo-graphic and bathymetric features. We replace the simulator by a Gaussian process emulator at each output location to overcome the large computational burden. The emulators are statistical approximations of the simulator's behaviour. We train the emulators on a set of input–output pairs and use them to generate approximate output values over a six-dimensional scenario parameter space, e.g. uplift/subsidence ratio and maximum uplift, that represent the seabed deformation. We implement an advanced sequential design algorithm for the optimal selection of only 60 simulations. The low cost of emulation provides for additional flexibility in the shape of the deformation, which we illustrate here considering two families – buried rupture and splay-faulting – of 2000 potential scenarios. This approach allows for the first emulation-accelerated computation of probabilistic tsunami hazard in the region of the city of Victoria, British Columbia.

How to cite.

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1 Introduction

The Cascadia subduction zone is a long subduction zone that expands for more than 1000 km along the Pacific coast of North America, from Vancouver Island in the north to northern California in the south (Fig. 1). The zone lies on the interface of the subducting oceanic plate of Juan de Fuca and the overriding lithospheric plate of North America. Earthquake-induced tsunamis generated from the Cascadia subduction zone pose an imminent threat for the west coasts of the United States and Canada but also other coastal regions in the Pacific Ocean. Historical and geological records show that great plate boundary earthquakes were responsible for large-tsunami events in the past (Clague et al., 2000; Goldfinger et al., 2012). A sequence of great earthquakes has been inferred for the region over the last ~6500 years with an average interval rate of 500–600 years (individual intervals may vary from a few hundred to 1000 years) (Atwater and Hemphill-Haley, 1997; Clague et al., 2000; Goldfinger et al., 2003, 2012). The most recent megathrust earthquake in the Cascadia subduction zone was the 1700 earthquake, the timing of which was inferred from records of an orphan tsunami in Japan (Satake et al., 1996; Satake, 2003). The moment magnitude (M_w) of the earthquake was estimated close to 9, with a rupture length of ca. 1100 km, likely rupturing the entire zone (Satake, 2003).

There exists a large level of uncertainty with regard to the level of destruction that similar events could cause in the future. Major tsunamis in historical times have not caused significant damage to infrastructure in the west coast of British Columbia (Clague et al., 2003). This is partly attributed to the scarce and less densely populated areas in the region. However, the risk of such an episode nowadays has increased following an increase in urbanization. The most recent major tsunami impacting the area was generated by the 1964 Great Alaskan earthquake on 27 March 1964. Although no casualties were reported in Canada, the tsunami caused millions of dollars in damage on the west coast of Vancouver Island (Clague et al., 2000, 2003). Studies examining the impact of tsunamis in Cascadia have mostly focused on a worst-case-scenario potential (Cherniawsky et al., 2007; Witter et al., 2013; Fine et al., 2018); a few probabilistic studies exist, primarily assessing hazard potential on the US coastline (Gonzalez et al., 2009; Park et al., 2017) for a limited number of scenarios at high resolution or at individual local points (Guillas et al., 2018) for a large number of scenarios but at a moderate resolution of 100 m. Davies et al. (2018) performed a probabilistic tsunami hazard assessment at a global scale.

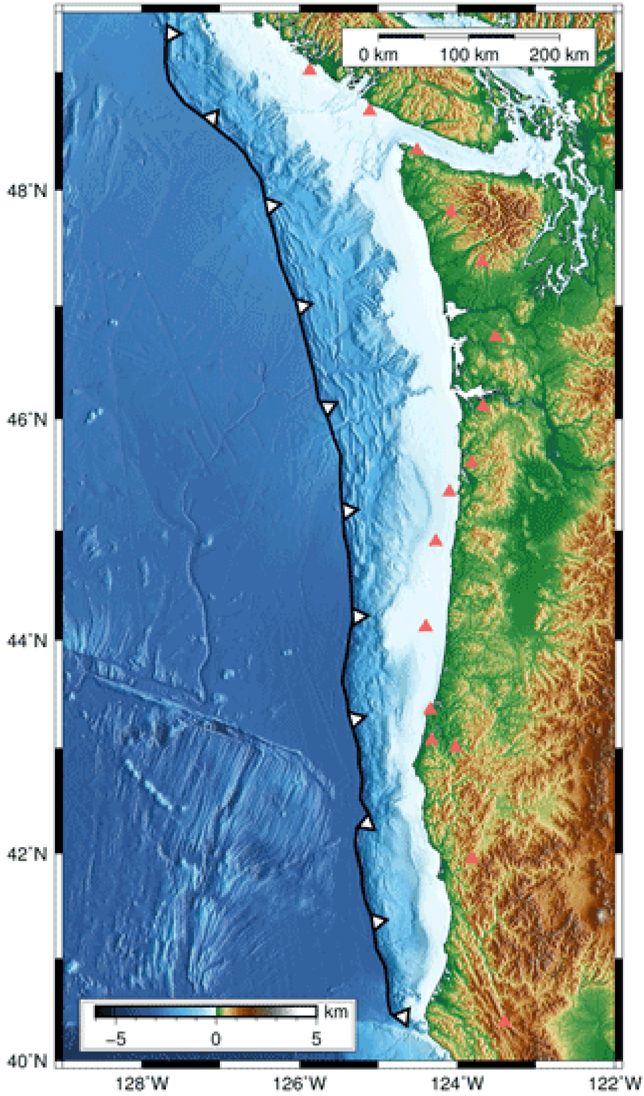


Figure 1 The domain of interest. The black line and white arrows depict the location of the trench; the orange triangles show the points used to drive the maximum subsidence. The reference point of the scale bar is assumed to be the bottom left corner of the map.

Probabilistic approaches allow for the exploration of large scenario distributions that benefit risk-informed decision making (Volpe et al., 2019). The probabilistic approach is to treat the uncertain scenario parameters as random variables and then propagate the parameter uncertainty to model the outputs. Uncertainty quantification aims to efficiently estimate the resulting variability in the simulation output, for instance in the simulated maximum tsunami wave heights on a set of locations. Thus, one needs to run the tsunami simulator for many scenarios with parameter values drawn from a chosen probability distribution, defining our prior belief about different scenarios' probability. High-accuracy, high-resolution computations are especially useful in tsunami modelling studies to assess inundation, damage to infrastructure and asset losses but also for evacuation modelling. The parameter space dimension is also typically high, and the number of expensive numerical simulations needed to resolve the statistics about the output tends to be large (on the order of thousands for a well-approximated distribution; Salmanidou et al., 2017; Gopinathan et al., 2021) and hard to materialize as it depends on the available resources, code architecture and other factors.

Statistical emulators (also known as statistical surrogate models) can be called to address these issues (Sarri et al., 2012; Behrens and Dias, 2015). We propose using a statistical surrogate approach, also called emulation, in which one approximates simulation outputs of interest as a function of the scenario parameter space. Such approaches have been implemented for uncertainty quantification of tsunami hazard at various settings (Sraj et al., 2014; Salmanidou et al., 2017, 2019; Guillas et al., 2018; Denamiel et al., 2019; Snelling et al., 2020; Gopinathan et al., 2021; Giles et al., 2021).

Statistical emulators are stochastic approximations of the deterministic response. They are used to predict the expected outputs of the response at untried inputs that fall within the prescribed input parameter intervals. Training data, which are the observations of the response at various settings, are used to build the emulators and are thus of paramount importance. In tsunami hazard, where observations of past events are limited, these training data originate from numerical experiments that have been mainly constrained by some physical understanding of the widest range of possible scenarios in order to cover any possible event through the emulation process since interpolation, not extrapolation, is the core technique. Extrapolation means predicting outcomes for parameter values beyond the parameter domain on which emulators are designed to interpolate. Since the points representing seabed deformation scenarios are in a bounded parameter domain, emulators can mitigate undesired extrapolation if built on a training design set with good coverage of the domain, particularly if the envelope of the design set is close to the domain boundary. For small design sets, which we consider in this work, sequential design strategies are advantageous as they update the design set to improved coverage, among other desired design features, by conditioning on the current design point locations. The role of experimental design in the scientific studies thus becomes critical as it aims to select the optimal sets of variables that contribute to the variance in the response and, in parallel, minimize the numbers of the runs needed for a desired accuracy. Several methods exist in the literature, from which two commonly occurring designs are the fixed (or one-shot) and the adaptive (or sequential) design. In fixed designs, such as the Latin hypercube sampling (LHS), the sample size of the experiments is prescribed. These designs have good space-filling properties but may waste computational resources over unnecessary regions of the input space. On the other hand, sequential designs adaptively select the next set of experiments to optimize the training data for fitting the emulators. Such a design can be determined by the efficient mutual information for computer experiments (MICE) algorithm (Beck and Guillas, 2016) that we utilize in this study for probabilistic tsunami hazard prediction in northern Cascadia.

Our study builds a methodology that employs existent methods and tools for the design of computer experiments and statistical emulation in order to quantify the uncertainty in tsunami hazard in British Columbia. The objective is to build multi-output Gaussian process (MOGP)[1] emulators and use them for probabilistic, high-resolution tsunami hazard prediction. Other surrogate model techniques have been applied for tsunami or tsunami-like applications, such as polynomial regression (see e.g. Kotani et al., 2020) and artificial neural networks (see e.g. Yao et al., 2021). For example, Yao et al. (2021) predicted tsunami-like wave run-up over fringing reefs using a neural network approach for approximating the relationship between inputs, including incident wave height and four reef features, and a wave run-up output on the back-reef beach. The authors emphasized that a disadvantage of artificial neural networks is that they are not suitable for small data sets. Owen et al. (2017) demonstrated, by examples involving computer-intensive simulation models, that GP emulation can approximate outputs of nonlinear behaviour with higher accuracy than polynomial regression when considering small- to moderate-sized, space-filling designs.

The benefit of this approach is the use of a sequential design algorithm in the training to maximize the computational information gain over the multidimensional input space and adaptively select the succeeding set of experiments. The vertical seabed displacement over the Cascadia subduction zone was defined by its duration and a set of shape parameters. We develop a site-specific idealized model for the time-dependent crustal deformation along the subduction zone, controlled by a set of shape parameters. In our study, the shape parameters are the model input, and the values define a specific scenario. The tsunami hazard was modelled using the graphics processing unit (GPU)-accelerated nonlinear shallow water equation solver VOLNA-OP2 (Reguly et al., 2018). The acceleration with GPUs makes it computationally feasible to run tsunami simulations on highly refined meshes for many scenarios. By a scenario, here, we mean a specific seabed deformation causing a tsunami outcome. For each location in a refined area of 5148 mesh locations at the shoreline of south-eastern Vancouver Island, we create a corresponding emulator of the expensive high-resolution tsunami simulator. The implementation of MOGP emulators finally allows us to predict the maximum tsunami wave heights (or flow depths) at shoreline level (H_{max}) at a high resolution, which can then be utilized to assess the probabilistic tsunami hazard for the region. We note that we compute the flow depth, as opposed to the wave height, for shoreline locations that have elevation above zero. The advantage of the design is that only a relatively small number of expensive tsunami simulator runs, which constitute the training data for the emulators, need to be performed. A fast evaluation of these emulators for untried input data is then performed to produce approximates of what the tsunami simulator output would have been. The emulators' technique of choice is a Gaussian process regression, which is also widely known as Kriging.

The novelty here is the use of the sequential design MICE by Beck and Guillas (2016) for the construction of the GP emulators of the tsunami model. This is done for the first time towards a realistic case using high-performance computing (HPC). A one-shot random sampling for the training (as for example in Salmanidou et al., 2017; Gopinathan et al., 2021; Giles et al., 2021) lacks the information gain achieved by sequential design. Concretely, sequential design can reduce by 50 % the computational cost, as demonstrated in Beck and Guillas (2016) for a set of toy problems, so applying this novel approach towards a realistic case is showcasing real benefits in the case of high resolution with a complex parametrization of the source. This work differs from the previous work by Guillas et al. (2018) in several aspects such as the high-resolution modelling, the sequential design approach, the complexity of the source and the use of the emulators for studying the probabilistic tsunami hazard in the region. The focus of our work is on the methodological aspect of building the emulators and using them for multi-output tsunami hazard predictions. For a comprehensive tsunami hazard assessment realistic modelling of Cascadia subduction interface magnitude–frequency relationships and seabed deformation parametrization needs to be incorporated. The study workflow followed in this study can be divided into three stages (Fig. 2): (I) the experimental set-up, (II) the experimental design, (III) the emulation and its use in hazard assessment. Each stage is described in detail in the following sections.

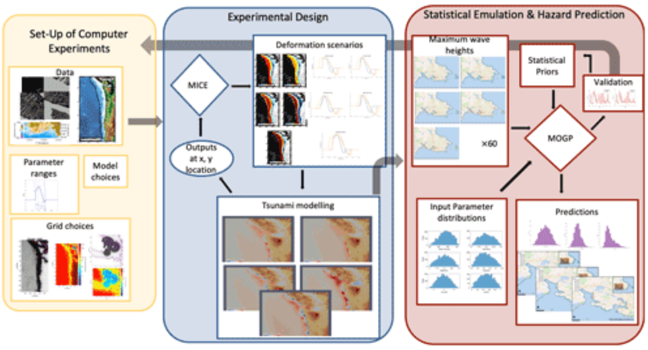


Figure 2 The graph of the workflow divides the study into three principal stages that are interlinked: stage 1 (yellow panel) comprises the study specification and set-up of the experiments, stage 2 (blue panel) comprises the study design and conduction of the numerical experiments, and stage 3 (red panel) comprises the building of the emulators and their use for prediction. The maps in the predictions section of stage 3 are produced with the QGIS software using as base maps the Wikimedia (https://maps.wikimedia.org, last access: 11 August 2021) layers with data provided by © OpenStreetMap contributors, 2021. Distributed under a Creative Commons BY-SA License (https://www.openstreetmap.org/copyright, last access: 11 August 2021).

2 Set-up of experiments

…

5 Conclusions

In this work, a sequential design algorithm was employed for the conduction of the computational experiments for earthquake-generated tsunami hazard in the Cascadia subduction zone. This approach aided an informative, innovative selection of the sets of numerical experiments in order to train the statistical emulators. It forms the first of its kind, to the authors' knowledge, which involves the application of a sequential design algorithm towards realistic tsunami hazard predictions through emulation. Focusing the high-resolution computations in the south-eastern part of Vancouver Island, H_{max} was predicted at 5148 coastal locations with the utilization of the emulators. Once the emulators are built, expert knowledge can be facilitated to swiftly assess hazard in the region. The flexibility of the method allowed here the prediction of thousands of scenarios in a few moments of time under different parameter set-ups. The hazard outputs demonstrated in the study resulted from 2000 potential rupture scenarios, the parameters of which were distributed following two hypothetical cases (2000 predictions case). The emulators' predictions were linked to their occurrence exceedance probability, which allowed us to produce probabilistic hazard maps that assess the hazard intensity of such events in the area (Fig. 13). This forms one way of representing the mean predictions under a probabilistic framework. Alternatively one could present other probabilistic statements, for instance assessing the probability of exceeding some given threshold of maximum tsunami run-up. This methodology could prove useful for assessing the hazard at the first stages of mitigation planning in order to take preventive measures such as built structures or natural hazard solutions.

The predictions showed a high dependence of the maximum wave heights (or flow depths) on the maximum uplift during the rupture. In the areas of Victoria and Esquimalt, the majority of the predictions tend to be under 1 m and most likely under 0.25 m. However, wave amplification is observed inside the harbours and especially in narrow bays and coves, possibly as an effect of wave resonance. When considering the maximum uplift distributions with a higher likelihood ranging between 4–7 m, the 90th percentile of the predictions shows that H_{max} ranged between 3–4 m at 6.29 % of the locations studied. In rare cases (at 1.9 % of the locations) the values may exceed the threshold of 4 m, falling within a range of 4–4.9 m. Similarly for the probabilistic tsunami hazard for exceedance rate, 4.19 % of the locations experience H_{max} above 1 m. These percentages are expected to increase when looking at larger return periods, and the hazard values have to be further assessed to produce a probabilistic risk assessment for the area.

This study expands on the methodology and the development of the workflow to build the emulators under a sequential design approach. As such, there are some aspects that need to be considered in future work to further refine the probabilistic outputs. These span from the tsunami generation to the inundation. In this case, an idealized geometry was used for the source, and the current results agree with the numerical studies of more incorporating fault geometries. However, to fully explore the complexity of the rupture, future work would benefit from the integration of compound rupture characteristics, especially when it comes to splay-faulting consideration. Furthermore, gaps and mismatches in the digital elevation data should be accounted for and incorporated in the modelling for a more finely resolved representation. Uncertainties and/or errors in the bathymetry and elevation data may play a critical role in the wave elevation outputs when assessing tsunami impact at a high resolution and can be included in the emulation (Liu and Guillas, 2017). Model bias is also not addressed in this study but could be explored in future investigations, for example by correcting the bias by adding a discrepancy estimated by comparing against past observations. Finally, to produce a complete hazard assessment in the region, probabilistic tsunami inundation should be carried out. This is enabled by highly nonlinear features in the emulators' predictions and even benefits from recent advances in emulation (Ming et al., 2021) whenever nonlinearities consist of dramatic step changes, e.g. in the case where over-topping of defences would generate vastly different flooding patterns.

(European Geosciences Union, Natural Hazards and Earth System Sciences, https://nhess.copernicus.org/articles/21/3789/2021)

ΝΕΑ ΑΠΟ ΤΙΣ ΕΛΛΗΝΙΚΕΣ ΚΑΙ ΔΙΕΘΝΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΝΩΣΕΙΣ

SIMSG ISSMGE

International Society for Soil Mechanics and Geotechnical Engineering

ISSMGE News & Information Circular December 2021

https://www.issmge.org/news/issmge-news-and-information-circular-december-2021

1. ELECTION OF ISSMGE PRESIDENT 2022-2026

As a consequence of the 20ICSMGE being pushed back to May 2022, and in accordance with the Statutes and Bylaws, the deadline for receiving nominations for the next ISSMGE President has been extended to 30th January 2022.

2. 20ICSMGE / 7iYGEC NEW DATES MAY 2022

New dates have been confirmed for the conferences in Sydney as follows;

7iYGEC - Friday 29 April - Sunday 1 May 2022
20ICSMGE - Sunday 1 May - Thursday 5 May 2022.

Registration is now open via the conference website https://icsmge2022.org/registration.php

3. TIME CAPSULE PROJECT (TCP) - Informal "showcases" to start in Nov 2021

The Time Capsule Project (TCP) aims to create and sustain a conversation about the past, present and future of geotechnical engineering to the benefit of our over 20,000 members. Contributions from all sectors of the ISSMGE, including legacy material, will be held and promoted through an online platform. This platform will be formally launched at the 20th ICSMGE (1-5 May 2022).

From November 2021 onwards, a series of informal and engaging "showcases" will be hosted to enable contributors to learn from each other's experience. Even draft contributions can be presented so we can learn from each other. The concept is novel and exciting even for us in the TCP Design Team!

For further information, please make contact with TCP Design Team directly or through the form available at: https://www.issmge.org/the-society/time-capsule .

4. VIRTUAL UNIVERSITY

The following have recently been added to the website:

Performance assessment of soils and structures by numerical analysis Prof. Toshihiro Noda

How to perform reliability analyses on a spreadsheet Dr Lei Wang

Collapse of Fujinuma Dam by the 2011 Great East Japan Earthquake and its reconstruction - Prof. Fumio Tatsuoka and Dr. Antoine Duttine.

Probability Analysis in Civil Engineering Prof. Jie Zhang

5. BULLETIN

The latest edition of the ISSMGE Bulletin (Volume 15, Issue 4, October 2021) is available from the website https://www.issmge.org/publications/issmge-bulletin/vol-15-issue-5-october-2021

7. ISSMGE FOUNDATION

The next deadline for receipt of applications for awards from the ISSMGE Foundation is the 31st January 2022. Click here for further information on the ISSMGE Foundation.

8. CONFERENCES

For a listing of all ISSMGE and ISSMGE supported conferences, and full information on all events, including deadlines, please go to the Events page at https://www.issmge.org/events. However, for updated information concerning possible changes due to the coronavirus outbreak (ie. postponements, cancellations, change of deadlines, etc), please refer to that specific events website.

As might be expected, many events have been rescheduled and we update the Events page whenever we are advised of changes.

The following are events that have been added since the previous Circular:

ISSMGE Events

TC106: RELEVANCE OF UNSATURATED SOIL MECHANICS IN PRACTICE - 15-12-2021 - 16-12-2021 Virtual platform, Kanpur Nagar, India; Language: English; Organiser: Indian Geotechnical Conference 2021, Indian Geotechnical Society; Contact person: Rajesh Sathiyamoorthy; Address: Department of Civil Engineering, IIT Kanpur; Email: hsrajesh@iitk.ac.in; Website: https://igc2021trichy.nitt.edu/pre-conference.php

New TC103 Course on "Performance assessment of soils and structures by numerical analysis" by Prof. Toshihiro NODA

About This Course

This course presents examples of performance assessment of soils and structures in quasi-static / dynamic problems. The assessments were performed using a soil-water coupled and elasto-plastic finite deformation analysis code developed by the presenters geomechanics research group.

This webinar is broadly divided into two parts.

I. Background & formulations (constitutive modelling & coupling finite deformation analysis)

The first part is on the concept of what I want to explain re

garding the subject of performance assessment for soils and structures.

(1) Background (Insight of current scenario) & Objectives (Problem presentation & solution)

The background and objectives of our geomechanics research group are presented along with the insight of the current scenario of this subject, particularly in Japan, as well as the problem statement and its possible solution. Subsequently, the extreme subdivision of the existing numerical analysis tools necessary for solving geotechnical problems is discussed. I also describe the theory and/or analysis tool aimed for, whose architecture can be compared to an Engine and a Chassis of a car.

(2) Outline of Engine (elasto-plastic constitutive model)

The engine represents an elasto-plastic constitutive model. It should describe the mechanical behavior with material nonlinearity of a wide variety of soils, from clay to sand through intermediate soils, consistently within the same theoretical framework. Therefore, the prerequisites of the constitutive model developed by our research group, namely the SYS Cam-clay model, are introduced. They are compared with the well-known Cam-clay model as a basic model. Moreover, examples of the possible behaviors described by the SYS Cam-clay model are presented.

(3) Outline of Chassis (Soilwater coupled finite deformation analysis)

The Chassis corresponds to continuum mechanics based on mixture theory, that is, soil-water coupled finite deformation analysis. The deformation analysis should describe the mechanical behavior due to the geometrical non-linearity, that is, effect of the change in the geometry. From this point of view, I show the formulation of the governing equations for the analysis as well as present a simple problem to emphasize the importance of the effect of change in geometry.

II. Analytical examples for quasi-static & dynamic problems

The second part of this webinar focuses on the examples of soft soil engineering problems in Japan, as quasi-static and dynamic problems, to which the analysis tool was applied. Based on these examples, I show the necessary geotechnical tools for the performance assessment of soils and structures from the viewpoints of unconventional and computational geomechanics.

(4) Static problem: Deformation to failure of soil

As for the quasi-static problems, an evaluation example is shown, in which a large deformation was targeted from deformation to failure of an ultrasoft soil comprising peat. At the start of our evaluation, a settlement of more than 10 m had already occurred on an embankment constructed on the soft soil of an expressway. Therefore, the prediction of future settlement, and examination of the countermeasures against large settlement are required.

(5) Dynamic problems: seismic performance evaluation

In regard to the dynamic problems, as you might know, Japan is an earthquake-prone country, and, indeed some big earthquakes have occurred in the past thirty years. These earthquakes caused devastating damages to the ground and soil structure as well as to buildings, bridges, and other structures. Therefore, I show two numerical examples of an artificial ground and a river levee on a soft ground.

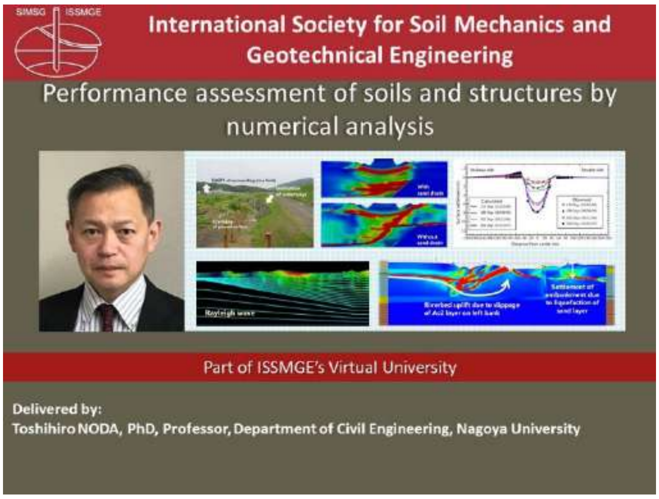
The 2011 Great East Japan Earthquake of Mw 9.0 caused a wide range of liquefaction of more than 40 km2 around Tokyo Bay, which was even approximately 400 km away from the epicenter. In this webinar, I discuss why such an earthquake motion caused severe liquefaction damage to artificial grounds.

Also, the Nankai trough subduction earthquake is expected to shortly hit the Tokai region. There are wide areas below sea level in the alluvial plains surrounded by river and coastal levee protections. As a second example, the seismic evaluation results for a river levee constructed on sand-clay laminated ground are shown.

These dynamic problems include rather new topics such as the damage due to the edge effect of the seismic motion resulting from the interference of direct body waves and basin-induced surface waves, and dynamic behavior of ultrasoft clay.

(6) Summary with short numerical examples

I conclude with a summary and some additional simple numerical examples.



Prof. Toshihiro NODA is a professor of Nagoya University, Japan. He is a graduate of and belongs to Department of Civil Engineering of the University. He has been engaged in the research and development on elasto-plastic constitutive modelling of soil and numerical analysis method in geomechanics since the master course. He currently focuses on researches on geodisaster prevention / mitigation against large earthquake and heavy rainfall.

TC 307 - ISSMGE SUSTAINABILITY COMMITTEE - STATUS REPORT & NEWS 4

Dear TC307 members,

Greetings! I welcome you to Status Report 4 from TC 307 (December 2021). I hope you and your family are well and the covid situation is not affecting you too much. I am writing you on several agendas that need your attention and/or action from you.

1. We all are aware that the 20th International Conference on Soil Mechanics and Geotechnical Engineering was postponed due to the COVID pandemic, and the new dates have been announced. The conference will now **begin on Sunday, May 1, 2022 and conclude on Friday, May 6, 2022.** The organising committee informed us that the new dates were selected in consultation with the ISSMGE Board and will not be amended again.

2. During the ISSMGE conference, TC307 is organising workshop/s, which may accommodate your paper for

presentation or may invite you to give a presentation. Therefore, it is essential to know your intention to attend the conference to facilitate the workshop, and I have organised a survey in survey monkey. I strongly encourage you to do the survey even though you are not attending the conference. It will hardly take more than three minutes of your time. Link: https://www.surveymonkey.com/r/G2FGC3V

3. In March this year, Olivier sent you an invitation for a short survey for time capsule project, for which Technical Committees of the ISSMGE have been asked to succinctly document the development of their area, most conveniently by decades, focussing on major breakthroughs and why that came about, with collateral material (papers etc.) that support their story. As TC307 members, I kindly ask you to complete this survey and to provide sufficient details/references. I understand *Sustainability in Geotechnical Engineering* is a relatively newer discipline compared to say, earthquake engineering; however that makes it more exciting for us to contribute. The link for the survey: https://enquetes.univ-lorraine.fr/index.php/323183?token=9OA1vFKVEpwPLT7&lang=en

4. ISSMGE developed a mobile app, which will update you for TC307 news and all valuable TC news to TC307 members and Geoprofessionals.

5. Conferences: the next CREST will be held during November 2023 here in Fukuoka. TC 307 will co-sponsor the conference and let us know (email) if you are interested in participating.

Any posts or conference announcements related to TC307 - please send them to us, and do not directly post them. If they are relevant to our committee works, we will post or include them in our next status report.

Thanks and Best Regards,

Prof. Md Mizanur Rahman, Secretary TC307

Special issue of the ISSMGE-IJGCH: "numerical methods in geomechanics"

The special issue of the International Journal of Geoengineering case Histories promoted by TC103, entitled "Numerical methods in Geomechanics" is on-line!

Read the papers at: https://www.geocasehistoriesjournal.org/pub

List of contents:

- Bekele, B., Song, C. and Lindemann, M. (2021). A Case Study on the Progressive Failure Mechanism of I-180 Slope Using Numerical and Field Observations
- Leelasukseree, C., Pipatpongsa, T., Chaiwan, A. and Mungpayabal, N. (2021). Practical Design, Numerical Analysis and Site Monitoring for Huge Arching Effect during Massive Excavation of Undercut Slope in Open-pit Mine
- Tashiro, M., Kawaida, M., Inagaki, M., Yamada, S. and Noda. T. (2021). Ex-Post Evaluation of Countermeasures Against Residual Settlement of an Ultra-Soft Peaty Ground Due to Test Embankment Loading: A Case Study in Maizuru-Wakasa Expressway in Japan
- Tanenaga, E., Fujisawa, K. and Murakami, A. (2021). Identification of Material Parameters by Particle Filter Using Observation Data Obtained during Construction of Rock-fill Dam
- Parsa-Pajouh, A., Azari, B., Mirlatifi, S., Buys, H. and Cullen, I. (2021). Numerical Analysis of a Top-Down Constructed Deep Basement with Diaphragm Walls in Sydney Barangaroo - A Case Study
- Creten, S., Verbraken, H., François, S. and Bauduin, C. (2021). Design, Construction, and Back-analysis of a Deep Underground Parking Garage in an Urban Environment
- Chan, C.L.C., Chiu, S.M.D., Lo, L.C.F., Kwan, S.H.J., Lee, S.W. and Leung, C.O.A. (2021). Back Analyses of Two Deep Excavations in Hong Kong using Mohr-Coulomb Model with Linear Elasticity and the Hardening Soil Model

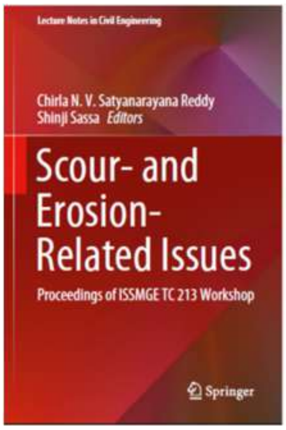
TC213 Meeting, Oct. 19, 2021

Agenda and Time schedule for the TC213 Meeting on Oct 19, 2021 at ICSE-10

Time schedule is in Eastern Daylight Time (EDT). EDT is 4 hours behind Coordinated Universal Time (UTC)

5:00 PM – 5:10 PM	Meeting outline by the TC chair (S. Sassa)
5:10 PM – 5:20 PM	Brief summary of the immediate past ICSE-9 in 2018 and the transfer of past ICSE materials to ISSMGE website by the TC vice-chair (C. Avila)
5:20 PM – 5:25 PM	Review of the ISSMGE TC 213 Workshop on Scour and Erosion in 2020 by the TC chair (S. Sassa)
5:25 PM – 5:35 PM	Overview of ICSE-10 by the conference chair (M. Xiao)
5:35 PM – 5:45 PM	Introduction to ICSE-11 in 2023 in Denmark by the host (T.U. Petersen)
5:45 PM – 6:00 PM	Presentation by a host candidate of ICSE-12 in 2025 (X. Fu) (Chongqing Jiaotong University (CQJTU) and Hohai University wish to co-organize the 2025 ICSE-12 in China)
6:00 PM – 6:10 PM	Voting for the host of ICSE-12 in 2025
6:10 PM – 6:25 PM	Discussion on recent ISSMGE initiatives: International Journal of Geoengineering Case Histories and Time Capsule Project (Potential contributions to the special issue on scour and erosion)
6:25 PM – 6:30 PM	Concluding remarks by the TC chair (S. Sassa)

The ISSMGE TC213 Workshop on Scour and Erosion in 2020 was attended by 368 participants from 18 different countries.



This book comprises chapters on scour and erosion related issues. It is an outcome of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE) Technical Committee 213 Workshop on Scour and Erosion that was held on December 16, 2020. The ISSMGE TC213 Workshop was attended by 368 participants from 18 different countries worldwide. The contents of this book reflect recent advances in the mechanics and countermeasures of scour and erosion, including coastal protection, erosion control, etc. Covering practical issues of geotechnical engineering with academic and research inputs, this volume will be a useful reference for academia and industry alike.

Previous issues contain papers on Scour and Erosion.

The "International Journal of Geoengineering Case Histories (IJGCH)" is an official journal of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE), focusing on the publication of well-documented case histories.

1. **Expedited Review and Publication**. High quality submittals may be reviewed and published within only 3 months.
2. **Open Access Publication and Wide Circulation**. All published papers are available online for digital download at no cost.
3. **Colored figures and electronic data are included in all papers**.

Technical Committees of ISSMGE are invited to contribute to the Special Issues of IJGCH

Special Issue on Scour and Erosion

ISSMGE TIME CAPSULE PROJECT (TCP)

Sukumar Pathmanandavel | Time Capsule Project | 21-04-2021

Opportunity/ Context

The coming decades, encompassing the centenary of the ISSMGE (2036), are predicted to bring unprecedented changes in all walks of life, through the underlying shift in world view and attitudes towards digital advances and sustainability considerations, accelerated by the necessary changes in practice and expectations that COVID 19 has brought.

Our opportunity is here and now to bring forward the creation of an entirely **Virtual Time Capsule (VTC)** that brings together and provides a common heritage to all geotechnical engineers.

Technical Committees to be asked to succinctly document the development of their area, most conveniently by decades, focussing on major breakthroughs and why that came about, with collateral material (papers etc) that support their story

Time Capsule Launch Date and Venue, 1-6 May 2022, 20th ICSMGE, Sydney, Australia

For the Time Capsule Project (TCP): TC213 contributions

Milestone: Scour and Erosion

- **Tenth Anniversary of International Conference on Scour and Erosion for the last twenty years**
- **Unique and distinguished standing in the ISSMGE TCs: Multi/interdisciplinarity with both geotechnical and hydraulic engineers**
- **ICSE conference series publications that involve guidelines with access from worldwide researchers and practitioners**
- **Virtual scour and erosion conference/workshop including young members: ISSMGE TC213 Workshop (2020), 10th International Conference on Scour and Erosion, ICSE-10 (2021)**
- **ICSE-11 in Denmark in 2023 and ICSE-12 in China in 2025**

TC106: RELEVANCE OF UNSATURATED SOIL MECHANICS IN PRACTICE

A pre-conference workshop entitled, *Relevance of Unsaturated Soil Mechanics in Practice* has been organized in association with TC 106 as part of the Indian Geotechnical Conference (IGC), the annual national flagship event of the Indian Geotechnical Society (IGS, New Delhi, www.igs.org.in). For the year 2021, IGC will be jointly hosted by the Indian Geotechnical Society, Trichy Chapter (www.igstrichy.org), and National Institute of Technology Tiruchirappalli, India on a virtual platform.

https://www.issmge.org/events/tc106-relevance-of-unsaturated-soil-mechanics-in-practice

Contact Information

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Website https://igc2021trichy.nitt.edu/pre-conference.php

Email hsrajesh@iitk.ac.in

☙ ❧

ISRM
International Society for Rock Mechanics and Rock Engineering

News

https://www.isrm.net

10 December is the deadline for submitting abstracts to RocDyn-4 2021-12-03

The Fourth International Conference on **Rock Dynamics and Applications (RocDyn-4)** will be held on 17-19 August 2022 in Xuzhou, China.

The main theme is for the conference is "Rock Dynamics: Progress and Prospect", with the aim to take stock of the significant progress that rock dynamics has made since the formation of the ISRM Commission on Rock Dynamics in 2008 and RocDyn-1 in 2013, examine new areas of research and applications, and look to the future of rock dynamics.

Prospective authors are invited to submit abstracts on all topics related to rock dynamics. Abstracts should be about 250 words long (not more than 1 page), with a title, authors' names, affiliations, and email address for the corresponding author. For more information and **submission of abstracts**, please click this link: **http://RocDyn.org**

36th ISRM Online Lecture 2021-12-13

For the 36th ISRM Online Lecture, the ISRM invited Prof. Charlie Li, from the Norwegian University of Science and Technology (NTNU). The title of the lecture is "Methodologies of underground rock support and applications". It will broadcast on the 17th December at 10 A.M. GMT at www.isrm.net.

Dr. Charlie C. Li received his BEng 1981 and his MEng 1984 in geological engineering from the Central South Institute of Mining and Metallurgy, China. He received his PhD in rock mechanics in 1993 from the Luleå University of Technology (LTU), Sweden. He was a research associate and then associate professor (Docent) at LTU until 2000. After that, he worked as a geotechnical engineer in the mines of Boliden Mineral Ltd. Sweden for 5 years. Since 2004 Dr. Li has been a professor of rock mechanics for civil and mining engineering at the Norwegian University of Science and Technology (NTNU). Between 2008 and 2013, he served in part-time as Chief Technology Officer in Dynamic Rock Support AS, which was a university spin-out technology company.

His research interests are in ground support, stability analysis of underground spaces, and mechanical properties of rock and rock masses. Underground rock support is one of his most focused research subjects. The most innovative achievements of his are the analytical models for rock bolts, the study on the behavior of inflatable bolts, and the invention of the D-bolt. The D-bolt technology has been used in deep mines of many countries for rockburst ground support. He has authored more than 100 scientific papers, published a book entitled "Rockbolting – Principles and Applications" and delivered 20 keynote speeches or invited lectures.

Dr. Charlie Li served as the ISRM Vice President for Europe between 2015 and 2019. He is a member of the Norwegian Academy of Technological Sciences.

The lecture will remain online so that those unable to attend at this time will be able to do it later. As usual, the attendees will be able to ask questions to the lecturer by e-mail during the subsequent five days. All online lectures are available from this page. The lecture will remain online so that those unable to attend at this time will be able to do it later. As usual, the attendees will be able to ask questions to the lecturer by e-mail during the subsequent five days.

New ISRM Course on Ground Control in Longwall Mining 2021-12-17

A new ISRM course on Ground Control Consideration in High-Production Longwall Mining in Australia has been added to the ISRM website.

This course was created in 2021 by Prof. Ismet Canbulat, from the University of New South Wales, Sydney. The course has an introduction and five parts:

Part 0 - Ground control consideration in high-production longwall mining in Australia

Part 1 - Principles of ground control management in Australian underground coal mines

Part 2 - Pillar mechanisms and practical design considerations

Part 3 - Ground support principles and design considerations

Part 4 - Understanding and quantifying coal burst phenomenon

Part 5 - Estimation of horizontal stress magnitudes from borehole breakout data (by Prof. Joung Oh of UNSW)

World Tunnel Day

Happy World Tunnel Day, also known as the Feast Day of Saint Barbara! Saint Barbara is known as the patron saint of miners and tunnelers. A tradition with new tunneling projects is to create a small shrine to Saint Barbara at the tunnel portal and ask her for protection during construction and to keep everyone safe. Today, the aim of World Tunnel Day (celebrated on the 4th of December) is to showcase and increase interest in tunneling projects worldwide and to promote the industry to students of all ages and the general public. And, as always, stay safe underground!

Scooped by ITA-AITES #57, 7 December 2021

Gateway Tunnel dig is all set to begin, except for $5.6 Billion | United States of America

Infrastructure Ontario, Metrolinx issue RFQ for second Eglinton Crosstown West Extension tunnel contract | Canada

Stonehenge tunnel contract awards on hold | UK

Japan-financed Davao City bypass road begins excavation | Philippines

Victorian Tunnelling Centre training for future | Australia

Will Uttarakhand get the world's longest road tunnel? | India

World's fifth longest undersea road tunnel opens on South Korea's west coast

Irish Sea link | The bridge and tunnel options deemed technically feasible by ex-ICE presidents

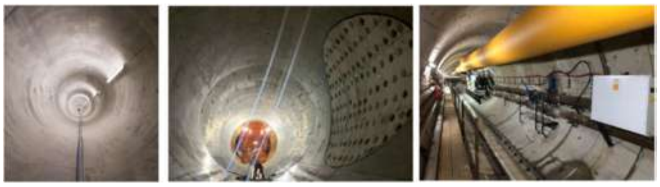
Construction work begins in Germany on road and rail tunnel to Denmark

Brenner Base Tunnel | Construction milestone hit on world's longest railway tunnel | Italy - Austria

Infrastructure bill secures billions for Hudson River tunnel | United States of America

Tideway Update

Andy Alder, Jennifer Her, Ignacio Tognaccini-Sainz & Matthew Campbell



Andy Alder, Tideway's Programme Director, will provide an update of the project's progress to date, and a lookahead towards completion.

His update will be followed by presentations from those working at three of the numerous Tideway worksites. These will give an appreciation of the scale and range of tunnelling and civil engineering activities taking place, and explain some of the technical challenges that have been overcome.

This is an in-person lecture (Thursday 9th December 2021) will also be streamed live at https://youtu.be/kZ9uc5KVKbQ

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New Zealand Geotechnical Society

New Zealand Geotechnical Symposium 2021

Τον Ιούνιο 2021 διεξήχθη το NZGS Symposium 2021 (ήταν να γίνη το 2020, αλλά λόγω covid έγινε το 2021). Το συμπόσιο έγινε με φυσική παρουσία, ενώ οι εκτός Νέας Ζηλανδίας συμμετείχαν μέσω skype https://www.confer.nz/nzgs2021/.. https://www.confer.nz/nzgs2021. Πρόεδρος της Οργανωτικής Επιτροπής του συμποσίου ήταν η Ελένη Γκέλη, τότε Αντιπρόεδρος και τώρα Πρόεδρος της New Zealand Geotechnical Society.

(σ.ε. Μήπως σας λέει κάτι το σήμα της New Zealand Geotechnical Society; Ποιος αντέγραψε; Εμείς ή αυτοί; Το δικό μας ισχύει από το 2010).

☙ ❧

International Geosynthetics Society
www.geosyntheticssociety.org

12th ICG Young Member Competition launched!

The IGS Young Member Committee is excited to announce the prestigious **Young Member Competition at the 12th ICG in Rome**. Ten of the world's best young researchers and engineers in geosynthetics will compete for the award for the best Young Member paper at the ICG Roma. The ten contestants will compete for the following prizes:

- **First prize** is USD1000 and an exclusive interview with the IGS News.
- **Second prize** is USD600.
- **Third prize** is USD300.
- All finalists will receive a certificate and the conference registration fee for the **10 finalists** will be waived.

The IGS Young Members Session will take place on **September 20** (Wednesday), **2023**. We are looking for highly qualified young members to take part. The ten young members will be selected from the papers submitted based on the discretion of a jury. From these ten the best lecturer will be selected based on the contents of the paper, style of the presentation and delivery.

Authors should be IGS members and **younger than 36 years** at the time of the event. Corresponding proof of membership and date of birth will be required. The candidate should be the first author of the paper and, in case you are chosen, also the presenter.

Abstracts should follow the guidelines of the 12 ICG and are due by February 28, 2022. Please note the **submission procedure** below. Please contact the IGS Young Member Committee if you have any questions: youngmembers@geosyntheticssociety.org.

Important dates

- **February 28, 2022**: Deadline for abstract submission
- **September 29, 2022**: Deadline for full paper submission
- **January 10, 2023**: Announcement of 10 Finalists
- **March 30, 2023**: Deadline for final paper submission

Submission procedure

1. Submit your abstracts using the online submission system ConfTool (as for a regular paper).
2. **Select the topic "20. Young Member Competition", together with another possible "regular" topic** (among those already available for the conference) which fits well with the paper content.
3. Aspiring contestants also fill out the Google Drive form maintained by the IGS YMC to indicate their interest in the competition. If aspiring contestants in the Young IGS Members Session have already submitted an abstract for the main program of the 12 ICG, please inform us of the corresponding abstract number (info@12icg-roma.org). Young Members who have submitted abstracts before the competition was launched can also fill out the Google Drive form afterwards.
4. Abstracts are reviewed following the processes put in place by the 12 ICG technical committee, without any input from the IGS YMC.
5. After the abstracts have been approved YM has an additional opportunity to apply for the competition.
6. Contestants and conference participants submit their papers following the conference procedures. Papers that are not approved for publication at the conference will not be considered for the competition.
7. Papers from contestants are reviewed following the standard conference procedure. However, in addition a jury rates the papers from the contestants.
8. The top 10 authors selected will present in the YM Competition session at the conference where they will be judged by the jury for the final rankings. The remainder of the participants will be considered for presentation at the standard technical sessions as per the conference guidelines.

Enter the competition

Topics

Sustainability with Geosynthetics	Landfills and remediation of contaminated sites
Geosynthetics Properties and Testing	Filtration and Drainage
Soil-Geosynthetic Interaction	Erosion Control and coastal applications
Durability and Long Term Performance	Hydraulic applications: canals, reservoirs and dams
Reinforced Walls and Slopes	Innovative materials and technologies
Basal reinforced Embankments, GEC, piles and shallow foundations	Design approaches and other applications
Seismic design with geosynthetics	Case Histories
Unpaved and paved roads	Mining applications
Railways and other Transportation Applications	Tunnels and underground constructions

See you in 2023!

Dear IGS Colleagues,

I hope this message finds you well as we approach the end of another eventful year!

In 2021, after the challenges of 2020, the world cautiously emerged from the worst of the pandemic. Now, with global health matters by no means resolved, the IGS and its members continue to confront the unpredictable with compassion and resilience.

I would like to pay tribute to the incredible resourcefulness of our members, chapters and committees in bringing health and safety to the fore while striving to ensure many events still went ahead, whether by adapting activities for an online audience or hosting hybrid events to make them as inclusive as possible. Together, we not only ensured the continuation of networking, educational and collaborative opportunities, but also opened these up to a wider audience.

Indeed, chapters continue to successfully evolve and develop amid global upheaval and change, and it is heartening to see the debut of a new chapter this year, IGS Nordics, and efforts being made to establish chapters in Bolivia and Guatemala.

In-person and online, the IGS Council has continued its efforts to improve its offerings, and innovate and inspire members with a range of initiatives, which I'm delighted to share with you here.

I spoke to you in June about the creation of three new IGS Task Forces – IGS Structure, IGS Credentialing, and IGS Recognitions, the latter of which is tasked with reviewing our current awards and honoring system. I'm delighted to announce its first action; creating four new named lectures recognizing outstanding members of the scientific and engineering geosynthetics community.

The named lectures are:

- The **Fumio Tatsuoka Lecture**, to be given at every GeoAsia conference
- The **Richard Bathurst Lecture**, to be given at the IGS Technical Committee on Soil Reinforcement session at every International Conference on Geosynthetics (ICG)
- The **Kerry Rowe Lecture**, given at the IGS Technical Committee on Barrier Systems' session at every ICG
- The **Kelvin Legge Lecture**, given at every GeoAfrica conference

I look forward to hearing the inaugural recipients making their addresses at these flagship events.

2021 has also seen the Council working hard to develop the new IGS website. Expect better functionality, navigation and interactive elements including a Chapter Map that displays contact details and upcoming events at the click of a button. Our growing Digital Library will also be packed with even more essential resources – including the IGS University lecture series videos.

Our revamped website is live so check it out and tell us what you think.

Our members are the society's lifeblood and none more so than our Young Members. This year we have been given a wonderful opportunity to widen the availability of our Job Shadowing scheme – which has seen pilots run by IGS Brazil and IGS Australasia – thanks to a donation from the IGS Foundation. The funding will allow the Young Members Committee to develop guidelines and promotional materials to help chapters implement the scheme in their region. Soon, more Young Members will be able to get one-day placements or benefit from a virtual one-to-one with participating IGS corporate member companies.

Broadening the availability of geosynthetics education and spreading greater understanding is a key focus for the IGS and I'm particularly proud of the continued and growing success of our Educate the Educators (EtE) program. We have a healthy pipeline of events next year, which we are confident we can grow even further, continuing to help professors share the latest developments in geosynthetics.

Our efforts to drive the debate on sustainability in geosynthetics was also reinforced this year with two deep-dive news features focused on recycling and energy conservation initiatives being implemented by key players in our industry. It is fascinating to see what companies are doing to make a positive impact on the environment. I would urge members to read and share these articles with their network for inspiration and motivation.

We'd also love to hear about the green initiatives you have in place, and can offer guidance if you'd like advice on making your operations greener. Visit our dedicated web page here where you will find a range of resources including our Sustainability eBook, now in nine languages, and 'Did You Know…' information sheets.

Many major conferences were disrupted in 2020 and we look forward with great anticipation to the re-scheduled GeoAsia 7 conference in Taipei, Taiwan, on October 31-November 4. And talking of conferences, in April, next year, we will be selecting the host chapter for the 13th ICG – thank you to all who applied.

Members looking for a new challenge should also stay tuned as we invite applications for Council members, Vice President, and President, as next year will be my final year leading the IGS.

We have many exciting new initiatives ahead, and I look forward to sharing these with you in due course. Until then, I wish you and your families a healthy and joyous holiday season, and continued success in 2022.

Chungsik Yoo

The NEW IGS Website is COMING SOON!

We are just days away! Please bear with us during this transition as there will likely be a few days where the IGS website is "Under Construction."

IGS Members: when the new site launches, you can use the same login credentials to access your membership account. In addition to using your Member ID# as your Username, you can also use your email address. If you have forgotten your password, please click on the "Lost Password" button.

Please contact igssec@geosyntheticssociety.org with any questions.

The IGS Digital Library has a new home!

The Digital Library can now be accessed at library.geosyntheticssociety.org, or through the tab on the new IGS website. Come check out the hub for all things geosynthetic! **Visit Digital Library**

The call for candidates for IGS Council, President and Vice President: term 2022 to 2026 is open! Nominations will close 1 March 2022 - don't miss this opportunity to serve on the IGS Council!

The IGS, in accordance with its bylaws, will hold elections in 2022. IGS Members will have the opportunity to elect **nine Council Members, a President and Vice President**. Each of the elected members will serve a four-year term, beginning on 3 September 2022.

The Council is the governing body of the IGS, responsible for the management of the Society in accordance with the bylaws, objectives and policies.

The IGS encourages any IGS Member who is interested in furthering the IGS Mission to consider standing for election. Council Members are required to attend all IGS Council Meetings during their tenure. The IGS Council normally meets once a year for a two-day period in conjunction with a major IGS event. IGS Council Members are expected to travel to these meetings and actively participate in discussions. Such meetings may take place in any world region, on rotation. Meetings may also be virtual. Council Members are also expected to take part in Committees established by the Council.

The elected IGS Council members whose terms of office conclude in 2022 are:

- Ian Fraser, United Kingdom (Treasurer)
- Edoardo Zannoni, South Africa (Secretary)
- Takeshi Katsumi, Japan
- Pietro Rimoldi, Italy
- Sam Allen, USA
- Dimiter Alexiew, Germany
- Jie Han, USA
- Jacques Cote, Canada
- Preston Kendall, Australia

Council Members may be elected for a maximum of two consecutive terms: Ian Fraser, Edoardo Zannoni, Takeshi Katsumi and Pietro Rimoldi are therefore not eligible for re-election to a Council Member seat. All other serving Council members may stand for re-election.

In addition to nine IGS Council seats, nominations are open for the positions of President and Vice-President. Both serve on Council, with the President as Chair. Any member of the IGS, including those who have served two consecutive terms on Council, may stand for the offices of President or Vice President.

Nomination & Election Schedule

Only IGS Members are eligible for election. Candidates are required to attend IGS Council meetings, which may be virtual or physical. These are typically held twice a year. Meetings of the IGS Council are generally held in conjunction with international and regional IGS conferences.

Call for Nominees and How to Apply

The call for candidates has officially opened and will also be shared in the January edition of the IGS Newsletter 2022, and on the IGS website. The call for nominations will close on 1 March 2022.

All IGS Members are encouraged to consider running for Council. Candidates should nominate themselves; there is no requirement for a proposer or seconder. Candidates for the positions of President and Vice President should clearly state they are standing for these positions. Please submit the following:

- your membership number (for verification purposes only)
- your country of residence. There is no restriction on the number of candidates from any country region
- a personal statement of no more than 200 words (350 words for President and Vice President). This may include a link to an online profile
- a photograph of yourself

All documents should be sent by email only to IGS Secretariat Manager at IGSsec@GeosyntheticsSociety.org on or before 1 March 2022. All documents should be editable - no pdfs please. Please use the email address you have registered with the IGS for your membership.

Announcement of Nominees: March 2022

The IGS will announce the eligible candidates in the March edition of the IGS Newsletter 2022, as well as on the IGS website. This will include candidates' country of residence, supporting statement and photograph.

Voting: 18 April to 18 June 2022

Voting instructions will be sent via email to each eligible Individual IGS Member and each designated representative from the IGS Corporate Membership. Each member may vote once and all voting will be done electronically. Please make sure you have submitted an accurate email contact to the IGS, which you can update by logging in to the IGS website.

Announcement of Successful Candidates: 1 July 2022

Successful candidates will be announced via the website on 1 July 2022.

The first meeting of the new IGS Council is expected to take place at the EuroGeo7 Conference in Warsaw, Poland, September 2022.

***

If you have any questions or would like any further information on the election process or the responsibilities involved in becoming an IGS Council Member, please contact the IGS Secretariat, Elise Oatman at IGSsec@GeosyntheticsSociety.org

Association of Geotechnical & Geoenvironmental Specialists

The AGS produce many publications including Safety Guidance, Position Papers, Client Guides & Loss Prevention Alerts. Most of these publications are available to download from the AGS website for free! https://lnkd.in/dw4Npjv.

ΔΙΑΚΡΙΣΕΙΣ ΕΛΛΗΝΩΝ ΓΕΩΤΕΧΝΙΚΩΝ ΜΗΧΑΝΙΚΩΝ

Βράβευση Μιχάλη Λοτίδη, Παύλου Νομικού και Αλέξανδρου Σοφιανού από την Ακαδημία Αθηνων

Οι συνάδελφοι Μιχάλης Λοτίδςη, Παύλος Νομικός και Αλέξανδρος Σοφιανός, της Σχολής Μεταλλειολόγων και Μεταλλουργών Μηχανικών του Εθνικού Μετσοβίου Πολυτεχνείου βραβεύθησαν από την Ακαδημία Αθηνών για το άρθρο τους, το οποίο εδημοσιεύθη στο περιοδικό "Rock Mechanics and Rock Engineering" με τίτλο "Numerical Study of the Fracturing Process in Marble and Plaster Hollow Plate Specimens Subjected to Uniaxial Compression".

Ο Μιχάλης Λοτίδης μετά την βράβευσή του

Numerical Study of the Fracturing Process in Marble and Plaster Hollow Plate Specimens Subjected to Uniaxial Compression

Michail A. Lotidis, Pavlos P. Nomikos & Alexandros I. Sofianos

Abstract

Physical models of plaster, calcitic and dolomitic marbles from greek quarries with a single pre-existing cylindrical hole of various diameters, subjected in uniaxial compression are simulated numerically with a bonded particle model by employing the two- and the three-dimensional versions of the Particle Flow Code. The linear parallel bond model is employed for the plaster's simulation, and respectively the flat-joint model for the marbles. The calibration procedure and results are presented, as well as the simulation results of the hollow specimens. The micro-cracking, the fracturing process and the sequence of their appearance during the numerical tests of the hollow plates are in good agreement with the laboratory tested physical models. Each fracture pattern is similar to the one of the physical models. Also, the regions of micro-cracking in the numerical models is quite similar to the regions of intense deformation observed from digital image correlation analysis on the respective physical models. The followed methodology for the determination of the phenomena's onset is presented as well. A comparison between the peak strength and the required applied axial stress for the primary fracture and spalling initiation of the numerical and the physical models is presented along with the accompanied scale effect. Additional numerical investigation is performed, quantifying the stress distribution along and normal to the primary fracture's path during the numerical test. The current study reveals the potential of the bonded particle model to reliably simulate laboratory and field structures, at least for the studied materials.

Rock Mechanics and Rock Engineering **volume 52**, pages 4361–4386 (2019), https://link.springer.com/article/10.1007/s00603-019-01884-8

Η Ελένη Γκέλη εξέλεγη Πρόεδρος της New Zealand Geotechnical Society

Η Ελένη Γκέλη εξέλεγη πρόεδρος της New Zealand Geotechnical Society, ενώ στην προηγούμενη θητεία ήταν Αντιπρόεδρος-Ταμίας (https://www.nzgs.org).

Η Ελένη ήταν Πρόεδρος της Οργανωτικής Επιτροπής του NZGS Symposium 2021, που διεξήχθη τον περασμένο Ιούνιο (ήταν να γίνη το 2020, αλλά λόγω covid έγινε το 2021). Το συμπόσιο έγινε με φυσική παρουσία, ενώ οι εκτός Νέας Ζηλανδίας συμμετείχαν μέσω skype https://www.confer.nz/nzgs2021/.

Τώρα είναι Principal Engineering Geologist - Technical Specialist Rock Engineering με την Stantec https://www.linkedin.com/in/eleni-gkeli-56b22184/

Eleni Gkeli

Eleni is an Engineering Geologist, with 20 years of experience in the geotechnical profession. She has a BSc in Geology, an MSc in Rock Mechanics and Foundation Design and a further MSc in Tunnel Design and Construction.

Eleni works for Opus International Consultants in Wellington as a Senior Engineering Geologist and heads the Engineering Geology and Rock Engineering team there. She has been involved in a variety of infrastructure projects across New Zealand, including the design of new highway routes and maintenance of the existing road networks, seismic upgrade of bridges, slope design and stabilisation works and various projects involving water infrastructure, buildings, tunnel upgrades and quarries. She was the lead for the tender design of the high rock cut slopes of the Transmission Gully motorway for Positive Connection Consortium and is cur-rently involved in the Petone to Grenada Link scheme assessment and the NZTA research project for the development of guidelines for the seismic design of high cut slopes.

Before coming to New Zealand in 2012, Eleni worked in Greece. She was initially based in Athens, working for various geotechnical consultancies, and then moved to Northern Greece to work in the Design Department of Egnatia Odos S.A. This is the managing authority of a 600 km long high standard motorway, designed and constructed between the years 1998 and 2009, for an approximate total cost of 6 Billion Euros. Through her role in this company, Eleni gained experience in the design and construction of large scale earthworks, bridges, tunnels and was exposed to the latest developments in geotechnical and seismic design in Europe by collaborating with internationally recognised experts in these fields.

ΠΡΟΣΕΧΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΚΔΗΛΩΣΕΙΣ

Για τις παλαιότερες καταχωρήσεις περισσότερες πληροφορίες μπορούν να αναζητηθούν στα προηγούμενα τεύχη του «περιοδικού» και στις παρατιθέμενες ιστοσελίδες.

GeoAfrica 2021 - 4th African Regional Conference on Geosynthetics Geosynthetics in Sustainable Infrastructures and Mega Projects, 21-24 February 2022, Cairo, Egypt, https://geoafrica2021.org

The 60th Rankine Lecture: The Unusual and the Unexpected in Geotechnical Engineering: Observation – Analogy – Experiment, 16 March 2022, Imperial College London, United Kingdom, London, https://www.britishgeotech.org/events/317-the-60th-rankine-lecture

15 - 17 March 2022, Kuala Lumpur, Malaysia
www.hydropower-dams.com/asia-2022

6th International Symposium on Tunnels and Shafts in Soils and Rocks
March 29 and 31 & April 5 and 7 2022, Mexico City, Mexico
www.smig.org.mx

The Mexican Society of Geotechnical Engineering (SMIG) and the Mexican Association of Tunnel and Underground Works Engineering, A.C. (AMITOS) are pleased to invite you to the 6th International Symposium on Tunnels and Shafts in Soils and Rocks, in the remote mode through the Zoom platform.

Receipt of abstracts and papers through: SiDiSMIG platform https://www.smig.org.mx/admArticulos/

Contact Information

Contact person: Miss. Brenda Aguilar
Address: Mexico City
Email: administracion@smig.org.mx
Website http://www.smig.org.mx
Email administracion@smig.org.mx

THE SECOND BETANCOURT CONFERENCE
"NON-LINEAR SOIL-STRUCTURE INTERACTION CALCULATIONS"
April 2022

Augustin Betancourt was an outstanding offspring of the Spanish nation and a citizen of the Russian empire, the founder of the Russian engineering school, the first head of a Russian agency for architecture and civil engineering. Betancourt Conferences are devoted to discussion of the important engineering problems faced by the professional community. The conference characteristic feature is involvement of experts of various profiles in discussion of relevant issues that fosters interdisciplinary communication and synthesis of knowledge.

The first conference held in June 2019 was devoted to underground urban planning, it drew attention of city planners, architects, geotechnical engineers, historical city preservation activists. Expectedly, the discussion of issues of underground space development resulted in creation of the regulatory document – Set of Rules 473.1325800.2019 "Buildings, structures and underground complexes. The rules of city planning design".

At the Second Betancourt Conference, which is going to be held in April in the format of video conference, we suggest to discuss burning issues of soil-structure interaction calculations taking into account non-linear and rheological properties of soils and structures which solution is impossible without a synthesis of engineering knowledge in the field of geotechnical engineering and design of superstructures.

For the Organizing Committee of the Conference

Professor Vladimir Ulitsky
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www.georec.spb.ru

16th International Benchmark Workshop on Numerical Analysis of Dams, 6–8 April 2022, Ljubljana, Slovenia, https://icold-bw2022.fgg.uni-lj.si

ICEGT-2020 2nd International Conference on Energy Geotechnics, 10-13 April 2022, La Jolla, California, USA, https://icegt-2020.eng.ucsd.edu/home

WTC 2022 World Tunnel Congress 2022 - Underground solutions for a world in change, 22-28 April 2022, Copenhagen, Denmark, www.wtc2021.dk

RaSim 10 Rockbursts and Seismicity in Mines, 24 – 29 April 2022, Tucson, USA, www.rasimsymposium.com

SYDNEY 7iYGEC 2021 7th International Young Geotechnical Engineers Conference A Geotechnical Discovery Down Under, 29 April - 1 May 2022, Sydney, Australia, http://icsmge2021.org/7iygec

SYDNEY ICSMGE 2021 20th International Conference on Soil Mechanics and Geotechnical Engineering, 1–5 May 2022, Sydney, Australia, www.icsgme2021.org

LARMS 2021 – IX Latin American Rock Mechanics Symposium Challenges in rock mechanics: towards a sustainable development of infrastructure, 15 – 18 May 2022, Asuncion, Paraguay, https://larms2021.com

Third International Conference on Geotechnical Engineering - Iraq 2022, May 17 –19, 2022, Baghdad, Iraq https://ocs.uobaghdad.edu.iq/index.php/ICGEI/ticgei

2022 ICOLD 27th Congress - 90th Annual Meeting 27 May - 3 June 2022, Marseille, France, https://cigb-icold2022.fr/en

CPT'22 5th International Symposium on Cone Penetration Testing, 8-10 June 2022, Bologna, Italy, http://cpt22.org

www.egrwse2022.com

Third International Conference on Environmental Geotechnology, Recycled Waste Materials and Sustainable Engineering, EGRWSE-2022 will be held in Izmir, Turkey from June 16 to 18, 2022 (www.egrwse2022.com). The symposium is hosted by Dokuz Eylül University, Department of Civil Engineering, Geotechnics Division.

EGRWSE-2018 and EGRWSE-2019 conferences were very successful events covering the state-of-the art research on environmental geotechnology, sustainability, and use of recycled waste materials for civil infrastructure. Participation to EGRWSE-2021 will benefit academic researchers, practicing engineers and representatives from local authorities. Besides presenting their own research or professional work, participants will be informed from and discuss latest accomplishments, innovations and future directions in environmental geotechnology, use of recycled wastes, and sustainability. Participants will connect with each other in order to develop networks and collaborations.

Conference Objectives

Environmental Geotechnology is an interdisciplinary science that covers soil and rock and their interaction with environment, which includes behavior of the soil-water system. The importance of Environmental Geotechnology has been increasingly recognized because of environmental pollution. In order to enhance living standards, we need more advanced, applicable and sustainable environmental technologies.

Recycling is the process of collecting and processing materials that would otherwise be thrown away as waste and turning them into new products. Various types of recyclable materials are currently in use in the construction industry. These include tire shreds, ground tire rubber, fly and bottom ash, blast-furnace slag, steel slag, cement kiln dust, silica fume, crushed glass, and other type of materials. Recycling is beneficial since it protects the environment and economically profitable. In order to elevate the use of recycled waste in civil engineering, research studies and documented field applications of recycled materials are needed.

Sustainable Engineering, within the scope of civil engineering profession, may be defined as the process of designing structures in such a manner that energy and resources are consumed sustainably either during construction stages or thereafter. Considering that earth's resources are rather limited in the face of population rise and demands of modern life style that is keen on high life standards, the engineer is responsible of creating design work that does not only involve best strength and stiffness considerations but also has sustainable point of view so that we do not compromise our environment and undermine the future of next generations.

The organizing committee, with above mentioned considerations, welcomes research and case study articles that cover environmental engineering, use of recycled materials in new design and construction or retrofit of existing structures as well as sustainable engineering approaches and their field applications.

Conference Secreteriat

Tuğçe ÖZDAMAR KUL, egrwse2020@gmail.com

3rd European Conference on Earthquake Engineering and Seismology (3ECEES), 19-24 June 2022, Bucharest, Romania, https://3ecees.ro

3rd International Symposium on Geotechnical Engineering for the Preservation of Monuments and Historic Sites 22-24 June 2022, Napoli, Italy, https://tc301-napoli.org

IS-Cambridge 2020 10th International Symposium on Geotechnical Aspects of Underground Construction in Soft Ground, 27 - 29 June 2022, Cambridge, United Kingdom, www.is-cambridge2020.eng.cam.ac.uk

5.ICNDSMGE – ZM 2020 5th International Conference on New Developments in Soil Mechanics and Geotechnical Engineering, June 30 to July 2, 2022, Nicosia, Cyprus, https://zm2020.neu.edu.tr

UNSAT2022
8th International Conference on Unsaturated Soils
June or September 2022, Milos island, Greece

ICONHIC2022: THE STEP FORWARD - 3rd International Conference on Natural Hazards & Infrastructure, 5 – 7 July 2022, Athens, GREECE, https://iconhic.com/2021

RocDyn-4 4th International Conference on Rock Dynamics an ISRM Specialized Conference, 17-19 August 2022. Xuzhou, China, http://rocdyn.org

ISFOG 2020 4th International Symposium on Frontiers in Offshore Geotechnics, 28 – 31 August 2022, Austin, United States, www.isfog2020.org

16th International Conference of the International Association for Computer Methods and Advances in Geomechanics – IACMAG 30-08-2022 – 02-09-2022, Torino, Italy, www.iacmag2022.org

11th International Symposium on Field Monitoring in Geomechanics, September 4 - September 7, 2022, London, UK, https://isfmg2022.uk

7th European Geosynthetics Conference, 4 to 7 September, 2022, Warsaw, Poland, https://eurogeo7.org

Eurock 2022 Rock and Fracture Mechanics in Rock Engineering and Mining, 12÷15 September 2022, Helsinki, Finland, www.ril.fi/en/events/eurock-2022.html

IAEG XIV Congress 2022, Chengdu, China September 14-20, 2022, https://iaeg2022.org

28th European Young Geotechnical Engineers Conference and Geogames, 15 – 17 – 19 September 2022, Moscow, Russia, https://www.eygec28.com/?

6th Australasian Ground Control in Mining Conference – AusRock 2022
17 – 19 September 2022, Melbourne, Australia

Organizer: UNSW Sydney, AusIMM
Contact Person: Ismet Cambulat
E-mail: icambulat@unsw.edu.au

10th International Conference on Physical Modelling in Geotechnics (ICPMG 2022), September 19 to 23, 2022, KAIST, Daejeon, Korea, https://icpmg2022.org

11th International Conference on Stress Wave Theory and Design and Testing Methods for Deep Foundations, 20 - 23 September 2022, De Doelen, Rotterdam, The Netherlands, https://www.kivi.nl/afdelingen/geotechniek/stress-wave-conference-2022

10th Nordic Grouting Symposium, 4 - 6 October, 2022, Stockholm, Sweden, https://www.ngs2022.se/

IX Latin American Rock Mechanics Symposium - Challenges in rock mechanics: towards a sustainable development of infrastructure, an ISRM International Symposium, 16-19 October 2022, Asuncion, Paraguay, http://larms2022.com

2022 GEOASIA7 - 7th Asian Regional Conference on International Geosynthetics Society, October 31 – November 4, 2022, Taipei, Taiwan, www.geoasia7.org

AUSROCK Conference 2022, 6th Australasian Ground Control in Mining Conference –an ISRM Regional Symposium, 29 November – 1 December 2022, Melbourne, Australia, www.ausimm.com/conferences-and-events/ausrock/

16th ICGE 2022 – 16th International Conference on Geotechnical Engineering, Lahore, Pakistan, 8-9 December, 2022, https://16icge.uet.edu.pk/

4th African Regional Conference on Geosynthetics – Geosynthetics in Sustainable Infrastructures and Mega Projects, 20-23 February 2023, Cairo, Egypt, www.geoafrica2023.org

88th ICOLD Annual Meeting & Symposium on Sustainable Development of Dams and River Basins, April 2023, New Delhi, India, https://www.icold2020.org

World Tunnel Congress 2023
Expanding Underground
Knowledge & Passion to Make a Positive Impact on the World
12 - 18 May 2023, Athens, Greece
https://wtc2023.gr

Rapid **urbanization**, natural **hazards**, **climate** change, sustainable **energy** geo-resources, people's mobility and transportation of goods are first-priority demanding challenges that the globe is facing.

Cities and infrastructure expansion towards underground provide safe, sustainable and **green solution** facilitating the transformation of millions of people's lives into a more **resilient** lifestyle. A comprehensive understanding, **rethinking and reshaping** of the underground spaces have become even more vital and crucial in the urban transformation of **future** cities. For the latter to be attained, planning and organization of **underground development**, a **holistic approach** is required not only in terms of spatial organization or overcoming engineering challenges, but also in regards to the establishments of policies, regulations and consideration of social factors.

WTC 2023 in Athens will highlight the multiple advantages and solutions that underground space could provide, at the prospect of a whole new era of **smart technology** where sophisticated **"digital tools"** change investigation, design, construction and operation methods and **strategies** rapidly. WTC 2023 will additionally provide an ideal opportunity to showcase recent innovations and the perspective of technology to further efficiently upgrade underground infrastructure assets, transforming the industry and the **societies** it serves.

Athens (Greece) has the knowledge, and we strongly believe we have the **means** and the **responsibility** to literally make a **positive impact** on the world.

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NROCK2022

The IV Nordic Symposium on Rock Mechanics and Rock Engineering
24 – 25 May 2023, Reykjavic, Iceland
www.nrock2023.com

Address

Icelandic Geotechnical Society Engjateigur 9 105 Reykjavík ICELAND
Contact Person Name Thorbjorg Thrainsdottir
Email jardtaeknifelagid@gmail.com

The 17th Danube - European Conference on Geotechnical Engineering
7-9 June, 2023, Bucharest, Romania
https://sites.google.com/view/17decgero/home

9th International Congress on Environmental Geotechnics
Highlighting the role of Environmental Geotechnics in Addressing Global Grand Challenges
25-28 June 2023, Chania, Crete island, Greece
www.iceg2022.org

The 9th International Congress on Environmental Geotechnics is part of the well established series of ICEG. This conference will be held on an outstanding resort in the town of Chania of the island of Crete in Greece. The theme of the conference is "Highlighting the role of Environmental Geotechnics in Addressing Global Grand Challenges" and will highlight the leadership role of Geoenvironmental Engineers play on tackling our society's grand challenges.

Contact Information

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- Email: rallisko@grid-engineers.com

17th Asian Regional Conference on Soil Mechanics and Geotechnical Engineering 2023
14-18 August 2023, Nur-Sultan, Kazakhstan
https://17arc.org

It is my great pleasure to inform you that the ***17th Asian Regional Conference on Geotechnical Engineering*** **will take place *on August 14-18 in 2023 at Hilton Astana Hotel, Nur-Sultan, Kazakhstan.*** The main theme of the 17 ARC is ***Smart Geotechnics for Smart Societies.*** Several subjects on modern geotechnical technologies and activities will be covered at during time of this forum. The 17 ARC is organized by the Kazakhstan Geotechnical Society (ISSMGE).

As the Chairman of the 17 ARC Organizing Committee, I cordially welcome your participation and kind support in this important event in 2023, including technical programs, exhibition, social events and other available and new information of the conference website (www.17arc.org) we will update with new information in the near future.

A number of subjects in modern geotechnical technology and activities will be covered up to match the main theme. In a roll about of 80 years, we sincerely hope that the 17ARC will continue to bring great success following the glories of past ARCs (New Delhi 1960, Tokyo 1963, Haifa 1967, Bangkok 1971, Bangalore 1975, Singapore 1979, Haifa 1983, Kyoto 1987, Bangkok 1991, Beijing 1995, Seoul 1999, Singapore 2003, Kolkata 2007, Hong Kong 2011, Fukuoka 2015, Taipei 2019).

Kazakhstan is located in the geographical center of Central Asia. Frequent flights make it convenient to get here from most cities in Asia and Europe. During the conference, all the guests can taste some of the finest cuisine, livestock meat can be cooked in various ways and is usually served with a wide range of traditional bread products, beshbarmak (horse meat). Refreshments often include black tea and traditional dairy drinks such as ayran (source milk), shubat (camel milk) and kymyz (horse milk). Kazakhstan is one of the safest countries to visit. Kazakhstan people are friendly and helpful. Kazakhs are always ready to welcome you with great and warm hospitality. It would be our great pleasure to welcome you to experience this great event and enjoy the dynamics of Nur-Sultan city (new capital of Kazakhstan).

Topics

- Soil characteristics and properties
- Engineering geology and rock engineering
- Impact of climate change
- Geo environmental engineering
- Shallow and deep foundations
- Slope debris flow and embankment
- Geotechnical reliability and geo hazards
- Soil improvement and geosynthetics
- In-situ testing and monitoring
- Offshore and harbor geotechnics
- In-situ testing and monitoring
- Codes, standards, definitions and terminology
- Industrial solutions in geotechnics
- Soil dynamics and earthquake engineering
- Numerical methods analysis
- Forensic engineering
- Training students and professionals in geotechnical engineering

Contact Us

Conference Secretariat info@17arc.org
Registration registration@17arc.org
Abstract Submission paper@17arc.org

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2023 15th ISRM Congress, International Congress in Rock Mechanics Challenges in Rock Mechanics and Rock Engineering, 9÷14 October 2023, Salzburg, Austria, https://www.isrm2023.info/en/

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https://wlf6.org

I would like to cordially invite you to be actively involved into the **6th World Landslide Forum "Landslides Science for sustainable development"** that will be held in Florence at the Palazzo dei Congressi from 14 to 17 November 2023.

The event is jointly organized by the International Consortium on Landslides (Kyoto, Japan), the International Programme on Landslides (IPL) and the UNESCO Chair on Prevention and Sustanaible Management of Geohydrological Hazards at the University of Florence.

The Forum is focused on Landslide Science for Sustainable Development, as a contribution to the Kyoto 2020 Commitment for global promotion of understanding and reducing landslide disaster risk (KLC2020).

Scientists, stakeholders and policy makers working in the area of landslide analysis, landslide disaster investigation and risk reduction are encouraged to share their work with the global community by submitting abstracts and presenting their work at the WLF6.

Themes and coordinators

1. **Kyoto Landslide Commitment for sustainable development**
   Kyoji Sassa, Matjaž Mikoš, Shinji Sassa, Khang Dang
2. **Remote sensing, monitoring and early warning**
   Veronica Tofani, Michel Jaboyedoff, Jan Klimes, Hans-Balder Havenith
3. **Testing, modeling and mitigation techniques**
   Binod Tiwari, Kazuo Konagai, Sabatino Cuomo, Xuanmei Fan
4. **Mapping, hazard, risk assessment and management**
   Paola Reichenbach, Snježana-Mihalić Arbanas, David Huntley, Maneesha Ramesh
5. **Climate change, extreme weather, earthquakes and landslides**
   Vít Vilímek, Alexander Strom, Stefano Luigi Gariano, Dalia Kirschbaum
6. **Progress in landslide science and applications**
   Zeljko Arbanas, Fawu Wang, Faisal Fathani, Beena Ajmera

Organizing Secretariat

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For general inquiries, please contact: info@wlf6.org
For inquiries about the scientific programme, please contact: session@wlf6.org
For inquiries about sponsor-related questions, please contact: sponsor@wlf6.org

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XII ICG - 12th International Conference on Geosynthetics, September 17 – 21, 2023, Rome, Italy, www.12icg-roma.org

World Tunnel Congress 2024
Shenzhen, China

China is the official host of the ITA-AITES World Tunnel Congress 2024 and 50th General Assembly.

The General Assembly which took place on June 30th by video-conference, has confirmed the candidacy of Shenzhen to organise the WTC 2024.

XVIII European Conference on Soil Mechanics and Geotechnical Engineering
25-30 August 2024, Lisbon, Portugal

Organiser: SPG
Contact person: SPG
Address: Av. BRASIL, 101
Email: spg@lnec.pt
Website: http://www.spgeotecnia.pt

ΕΝΔΙΑΦΕΡΟΝΤΑ ΓΕΩΤΕΧΝΙΚΑ ΝΕΑ

Destroyed section of Hwy 1 was deemed 'high risk' of landslide in September post-wildfire report

Assessments identify several other sites, including residential areas, at risk of slides and floods

The collapsed section of Highway 1, spanned by a rail bridge, at Tank Hill, near Lytton, B.C., on Nov. 15. The surrounding hillsides had been scoured by wildfires earlier in the year. (B.C. Ministry of Transportation/Twitter)

A section of the Trans-Canada Highway destroyed by a mudslide east of Lytton, B.C., last week was identified months ago as being at risk of landslides and flooding following a devastating wildfire in the area this summer.

The area at Tank Hill was just one of at least a dozen "high risk" or "high hazard" locations identified among 54 initial post-wildfire risk assessments compiled by the Ministry of Forests, Lands and Natural Resources Operations in recent months. The ministry released the initial assessments that identify high risk to CBC News.

Entire neighbourhoods, highways and recreation areas are among the sites identified at risk of experiencing devastating landslides, flood, debris flows and water quality issues.

The assessments are raising alarms about the effects of future disasters in the wake of last week's unprecedented rainfall and the summer's wildfire season — the third most destructive in B.C.'s history.

Lytton wildfire highlights risk

Fire-damaged landscapes hit by intense rainstorms or snow melt create a threat of landslides, floods and debris.

Very hot fires form a hard, water-repellent crust on the soil that can't absorb water, which just runs off. Fires also remove vegetation that protects against erosion.

Less than four months ago, during a spell of record-breaking high temperatures, a wildfire consumed the town of Lytton and swept across surrounding hillsides, leaving burned scrub and heat-hardened soil behind.

On Sept. 17, the B.C. Wildfire Service and the Ministry of Forests released an initial assessment of the risks and hazards created by the Lytton fire.

The washed-out section of Highway 1, along the Thompson River on Nov. 15. A post-wildfire report in September warned the highway was at 'high risk' of landslide. (B.C. Ministry of Transportation/Twitter)

"Recent rainfalls in mid-August initiated erosional sedimentation events in numerous small watersheds leading down to the [Trans-Canada] highway," wrote Tim Gilles, an independent geotechnical engineer.

The report also identified lighter flooding and debris flows in and around Nicomen Indian Band land east of Lytton, and rated the risk to homes and infrastructure as "high."

Work to minimize the impact of a slide had already begun, according to B.C.'s Ministry of Transportation.

In a statement to CBC News, the ministry said it had "completed temporary mitigation work along the corridor and had mitigated impacts from previous rainfalls (ditching, culvert clearing) while longer-term options/solutions were being assessed."

"Tank Hill was one of the areas that the ministry was watching as a result of the wildfires. It is important to note that this was a historic rainfall event."

Ken Gillis, board chair of the Thompson-Nicola Regional District, told CBC News the region was informed of the assessment. He said the mitigation work undertaken was as much as could have been reasonably expected in such a relatively short time.

High-risk sites

According to the ministry, a "high hazard" designation indicates a high probability of a hazardous event such as a flood, landslide or debris flow. "High risk" indicates that such a hazard is likely to affect homes, roads or facilities like recreation sites.

Among the most concerning areas identified by the ministry are parts of the large expanse burned by the White Rock Lake fire this summer.

The initial assessment warns of a high risk of landslides and moderate risk of flooding to dozens of homes on both sides of Monte Lake, along with area highways.

In August, more than 250 homes were evacuated and around 30 structures in the Monte Lake area were destroyed by the fire, one of the biggest of the past fire season.

Another slide-damaged section of Highway 1 at Tank Hill on Nov. 15. (B.C. Ministry of Transportation/Twitter)

It also destroyed almost 80 homes in neighbourhoods along the northwestern shore of Okanagan Lake. Scorched hillsides above Westside Road and the Killiney Beach area now threaten to unleash floods and landslides through neighbourhoods that survived the summer flames, according to the White Rock Lake assessment.

Risk assessments are ongoing, but other areas deemed high risk after an initial assessment include:

- Along the Trans-Canada Highway near Siska Creek and Saw Creek, south of Lytton, which is at high risk of flooding and debris flows.
- The north slope of Bill Nye Mountain near Cranbrook, which is at risk of debris floods that could threaten a half-dozen homes.
- The Gladstone and Van Houten recreation sites near Fauquier, around 100 kilometres east of Kelowna, which are at high risk of debris flow.

More assessments have yet to be completed, including a report of the impact of the Sparks Lake fire, the summer's largest blaze.

(Tom Popyk / CBC News, Nov 24, https://www.cbc.ca/news/canada/british-columbia/post-wildfire-report-warned-trans-canada-highway-at-risk-for-landslide-1.6258963)

An update on the Mira Mar landslide in Albany, Australia

In October I wrote about an ongoing landslide that is causing very significant problems for the residents of a neighbourhood in the Mira Mar suburb of the city of Albany in the southern part of Australia. At this spot a slow moving landslide has progressively destroyed or damaged a number of houses. The event remains contentious, with claims and counter-claims as to whether the cause is high levels of rainfall or the leakage of a water main. The slope has been moving since at least 2013, but it dramatically accelerated in the winter of this year. On 30 July a water main ruptured.

Last week a geotechnical report was released by a consultant, CMW Geosciences, commissioned by the Great Southern Development Corporation. This has been placed online. This is not a detailed site investigation, but it is instead primarily a desk study. However, this site has been extensively studied in recent years, and there is a movement monitoring record for the last few weeks, so the study usefully summarises the state of play.

Perhaps strangely, the report contains neither an interpreted plan view of the landslide nor an interpreted cross-section. I would be interested to know why this is not present. At the back of the report there are photographs of the landslide, including these images of surface damage:

Ground deformation in the Mira Mar landslide in Albany, Australia. Image from a geotechnical report by CMW Geosciences.

The report concludes that the landslide is complex, active and extending in size. It also notes that groundwater is likely to be the cause of the landslide, but it is clear that it is not possible to determine whether the source was rainfall or leakage. The report recommends that dewatering of the landslide is enhanced. In the short term the report recommends that two houses (10 and 12 Sleeman Avenue – see image below) are demolished – the damage to the houses means that they are unsafe and demolition would provide access for investigation and remediation. Finally the report recommends a more detailed investigation, using Lidar to understand the topography and morphology of the slope, and boreholes to understand the subsurface geometry, materials and pore water pressures. All of these recommendations seem reasonable.

The Minister for Regional Government has provided a response to the report that indicates that a further three properties will be evacuated, that AUS$150,000 will be made available for further investigations and that dewatering will be supported. It is probably true to say that the response has not been welcomed by those affected by the landslide.

This event is a nightmare for the residents of the properties on the landslide, and for those living around it. The report is correct in noting that the long term solution will need to address the stability of the whole landslide system, not individual properties. This is entirely possible from an engineering perspective, but it will be complex and expensive, and will require a long period of investigation, planning and construction.

Damage to a house caused by the Mira Mar landslide.

(Dave Petley / THE LANDSLIDE BLOG, 7 December 2021, https://blogs.agu.org/landslideblog/2021/12/07/an-update-on-the-mira-mar-landslide-in-albany-australia)

India says it's working with UK on prototype for landslide warning system

The Geological Survey of India (GSI) in collaboration with the British Geological Survey (BGS) has developed a prototype regional Landslide Early Warning System (LEWS) for India, the government said

Landslide in Himachal Pradesh.

The Geological Survey of India (GSI) in collaboration with the British Geological Survey (BGS) under the National Environmental Research Council (UK) funded, multi-consortium LANDSLIP project has developed a prototype regional Landslide Early Warning System (LEWS) for India, the Parliament was told on Thursday.

"The project is currently being evaluated and tested by the GSI in two pilot areas in India. One at Darjeeling district in West Bengal, and the other at Nilgiris district in Tamil Nadu," Earth Sciences Minister, Dr Jitendra Singh, told the Rajya Sabha in a written reply.

The GSI, through the LANDSLIP project is engaged in developing an experimental regional LEW) based on rainfall thresholds since 2017. The LANDSLIP research has developed a prototype model in 2020 based on the terrain-specific rainfall thresholds for two test areas.

The LANDSLIP is currently in the process of transferring the above tools of regional LEWS to the national nodal agency (GSI) for carrying out a similar endeavour in multiple landslide-prone states in India. Since 2020 monsoon, the GSI has also started issuing daily landslide forecast bulletins during monsoon to the district administrations in the two pilot areas for testing and evaluation.

The GSI is a part of the consortium constituted by the National Disaster Management Authority involving scientists from various institutes/organisations viz. National Institute of Hydrology, the National Remote Sensing Centre/the Indian Space Research Organisation, the Wadia Institute of Himalayan Geology, the Defence Geoinformatics Research Establishment, IIT-Roorkee etc. This consortium works with an objective to explore the possibility of suggesting methods of monitoring and early warning to forecast site-specific rock/snow avalanche events including glacier lake outburst flood/landslide lake outburst flood and reducing the cascading impacts like flash flood and landslides etc. as domino effects in the downstream areas.

The GSI has initiated the R&D activities and the groundwork for developing regional LEWS in other test areas like Uttarakhand, Kerala, and Sikkim from 2021 and also has a plan to add five additional states (Himachal Pradesh, Karnataka, Assam, Meghalaya, and Mizoram) by 2022.

The evaluation and calibration of the models will continue during the next few monsoon years and the regional LEWS will be made operational in phases in all such 10 states after successful ground evaluation, with effect from 2025 onwards, the Minister said.

https://www.business-standard.com/article/current-affairs/india-says-it-s-working-with-uk-on-prototype-for-landslide-warning-system-121120201543_1.html

Mundesley, Norfolk, UK coast landslide

A large section of cliff collapsed on to a beach. It happened close to houses in Mundesley, Norfolk, sometime between Wednesday night and Thursday morning. The coastguard said heavy rain had made the cliffs very unstable.

(BBC News, Dec 9, 2021, https://www.bbc.com/news/uk-england-norfolk-59600753)

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Follow up of Melamchi Disaster, North of Kathmandu, Nepal

The photo (taken on December 5, 2021) shows the debris flow deposit in Melamchi Bazar area. The disaster happened in series of events from June 15 and August 1, 2021. The main town was buried during the event. Later, people cleaned the buried sediment and now are using their houses. We can see the partly buried photo of residential houses and hotels. The main economy of this area depends on Himalayan herbal trades and tourism. Most of people collect the Himalayan Cordyceps sinesis (YARSHA GUMBA) in the higher elevation and sell it to run their livelihood well in the town. At present, Dr. Ranjan Kumar Dahal (coordinator of IAEG national group of Nepal) and his team (includes Dr. Manita Timilsina, Ms. Chandani Bhandari, Ms. Ajeena Dahal and Mr. Om Prasad Dhakal) are now working for rehabilitation and restoration of the river and Melamchi Bazar.

(IAEG Connector E-News December 8, 2021, https://www.multibriefs.com/briefs/IAEG)

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Excavation Support

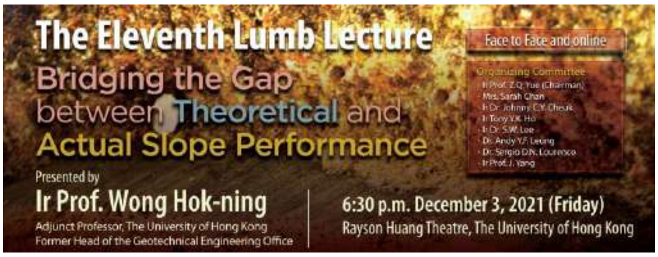
Rakers are one of the least favorable options for support of excavation because they interfere with the slab and basement construction. Sometimes though they are your only option.

50 Tons of bottom steel for the first mat plus a few footings set in 2 days!!!! Bayshore Rebar and Madison Concrete Construction at 12th and Sansom, Philadelphia PA!!!

(Richard Stone, https://www.linkedin.com/feed/update/urn:li:activity:6872296134790975488)

☙ ❧

The 11th Lumb Lecture at HKU: Bridging the Gap between Theoretical and Actual Slope Performance by H.N. Wong



Professor H.N Wong is the former head of the Geotechnical Engineering Office in Hong Kong, the agency charged with responsibility for slope management in the territory. Last Friday he delivered the 11th Lumb Lecture at Hong Kong University, entitled "Bridging the Gap between Theoretical and Actual Slope Performance".

The lecture is held every two years in memory of Professor Peter Lumb, who for 32 years was an academic in the Department of Civil Engineering, The University of Hong Kong. He was a towering figure in geotechnical engineering in Hong Kong, and indeed globally, and much of the success in managing slopes in Hong Kong is built upon his work and that of his students.

In his lecture, H.N. Wong drew upon multiple examples from Hong Kong. He highlighted the uncomfortable fact that the failure rate for engineered slopes is much higher than that of other engineered structures. H.N. notes that one of the issues is that there is a large gap between theoretical and actual slope performance. The lecture explores ways to both understand this issue and to address it.

The lecture has been posted online and can be viewed for free. I thoroughly recommend it.

Synopsis: Bridging the Gap between Theoretical and Actual Slope Performance by H.N. Wong

Unlike other types of modern-day engineering structures, slopes that are engineered according to sound geoscience theories and meeting state-of-the-art standards still suffer from an appreciable chance of failure. This unsettling fact was not previously evident to the geotechnical community at large. It was also unfamiliar to the local practitioners during the formative years in the first one to two decades of implementing the system for mandating the application of geotechnology in Hong Kong's slope engineering. Despite this, the notable improvement in slope safety made at the time has rendered Hong Kong internationally reputable as a model of slope engineering in an urbanized setting. Yet, as time went by when more engineered slopes had been formed and their actual performance tested under heavy rains, the bitter lesson was learnt of the gap between theoretical and actual slope stability. The systematic landslide investigations and related technical development studies launched by the GEO since the mid-1990s has provided comprehensive findings on failures of engineered slopes and important insights into the causes. This has brought about enhanced understanding of the need and impetus for further improving the relevant slope engineering practices. While the experience and knowledge have emerged primarily from Hong Kong, it is relevant to urban slope engineering and landslide risk management elsewhere.

This Lecture aims to show, with reference to the available data and selected case histories, the extent and causes of the disparity between the theoretical and actual slope performance in Hong Kong. In this context, the key improvement measures adopted over the years with some degree of success in bridging the gap will be explained. This will illustrate the importance of robust geotechnical design and holistic landslide risk management. Cautioning against complacency particularly in the wake of the new challenges that may arise from climate change, the Lecturer will also discuss issues yet to be addressed and some possible solutions.

(Dave Petley / THE LANDSLIDE BLOG, 10 December 2021, https://blogs.agu.org/landslideblog/2021/12/10/the-11th-lumb-lecture)

The failure of retaining walls

Retaining walls are an essential part of modern construction. In general they perform remarkably well; occasionally they fail and find their way onto this blog. You should be able to find a list of examples here, and some posts have included videos and spectacular photographs, such as this:-

The highway slope failure at Düzce Zonguldak in Turkey on 26 March 2021. Image from Haber Golkoy.

Loyal reader George Haeh has very kindly highlighted a link to an interesting video that describes types of retaining walls and the mechanisms through which they may fail. The video should be embedded below:-

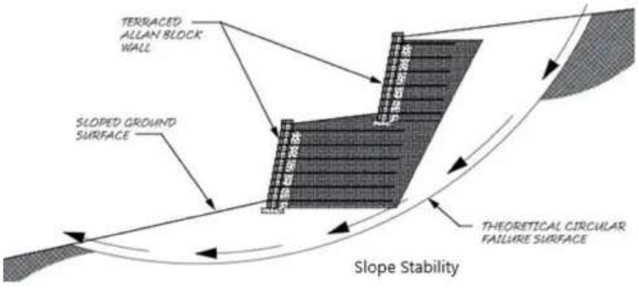
https://www.youtube.com/watch?v=--DKkzWVh-E

Whilst it is not technical, it is a good summary. An interesting aspect of the video is that it includes an interesting example of a retaining wall failure from New Jersey:-

A retaining wall failure on I-295 in New Jersey in April 2021

This failure of a retaining wall has further delayed an already deeply troubled project (it was originally supposed to be completed in 2022, even before the failure this had been delayed until 2028. In this case an investigation has indicated that the problem may have been higher than anticipated groundwater levels that caused "a partial collapse of a column-supported embankment system". It is interesting to note that in the image above it appears that mass was being added to the toe of the slope, which is sensible way to stabilise the slope temporarily.

One of the key failure modes for retaining walls is a slope failure that goes through material upon which the wall has been constructed. This is the idealised cross section of such a failure:-



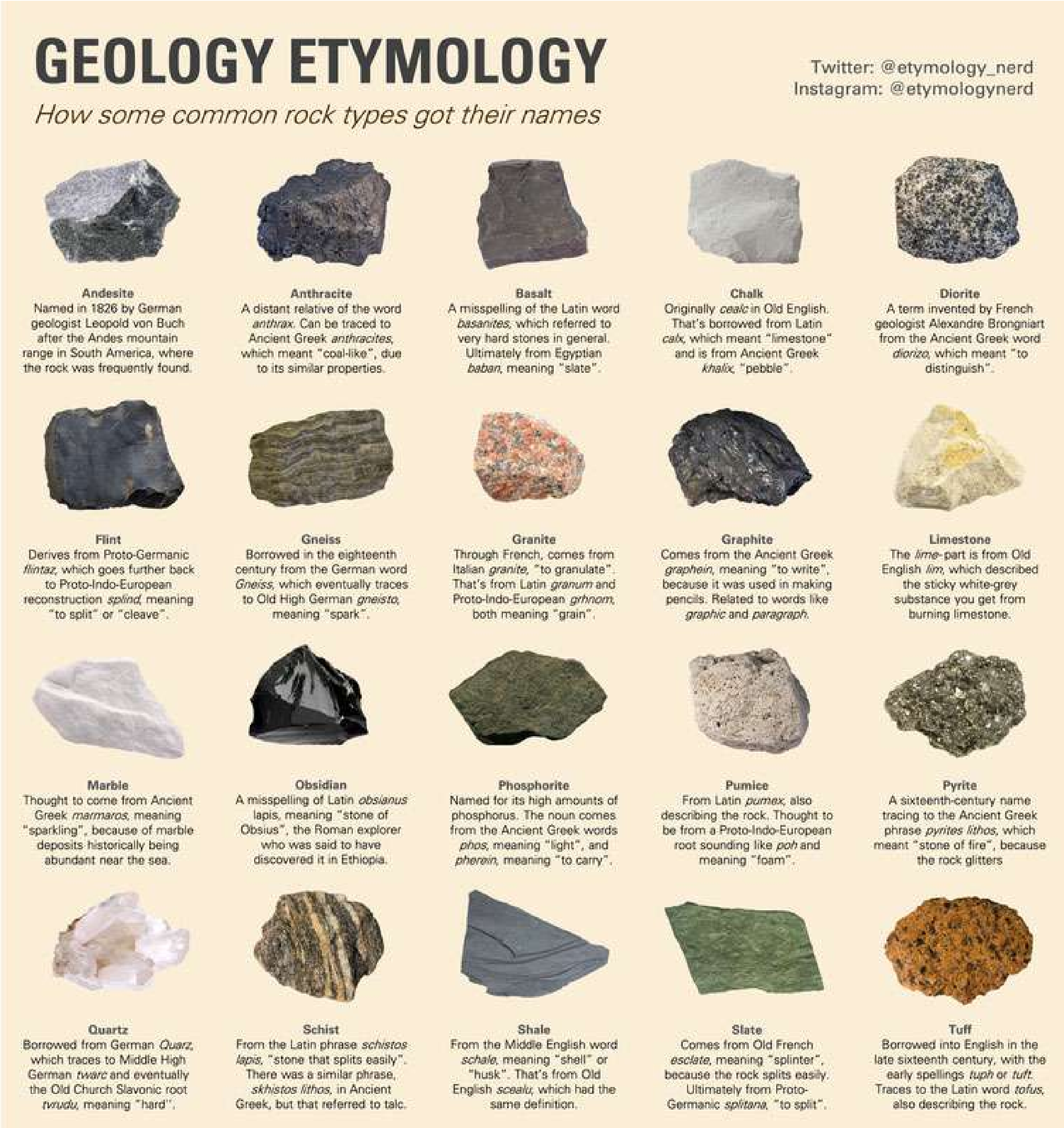
An idealised cross section of one key mode of failure of a retaining wall. Image from structuralguide.com.

Readers may spot some similarities between this cross section and the examples shown above. Way back in 2010 I highlighted another really interesting case study, at the Rivermist subdivision in San Antonio, Texas.

(Dave Petley / THE LANDSLIDE BLOG, 13 December 2021, https://blogs.agu.org/landslideblog/2021/12/13/retaining-walls)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΓΕΩΛΟΓΙΑ

How some common rock types got their names



ΗΛΕΚΤΡΟΝΙΚΑ ΠΕΡΙΟΔΙΚΑ

International Journal of Geoengineering Case Histories

An official journal of the International Society for Soil Mechanics and Geotechnical Engineering

Issue 4, Volume 6

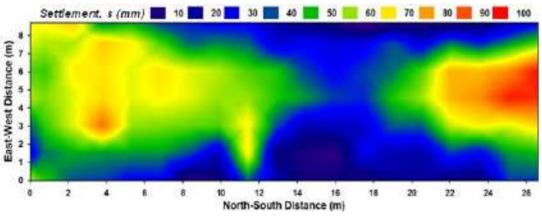
www.geocasehistoriesjournal.org/pub/issue/view/50

Issue 4 of Volume 6 is a Special Issue organized by the ISSMGE Technical Committee TC304 on "Engineering Practice of Risk Assessment and Management" and includes eight recent case histories that demonstrate the developments and applications of geotechnical risk assessment and management approaches in engineering practice. The Guest Editor of the issue is Dr. Andy Yat Fai Leung, Associate Professor, Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University in Hong Kong.

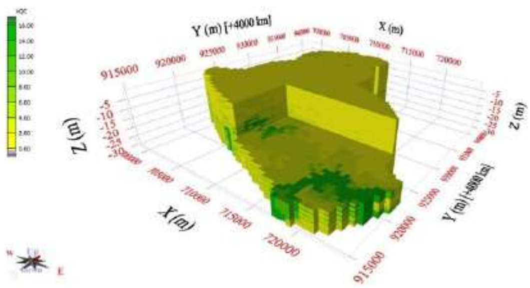
The contents of the Special Issue and direct access to the papers are provided below.

Editorial by Andy Yat Fai Leung

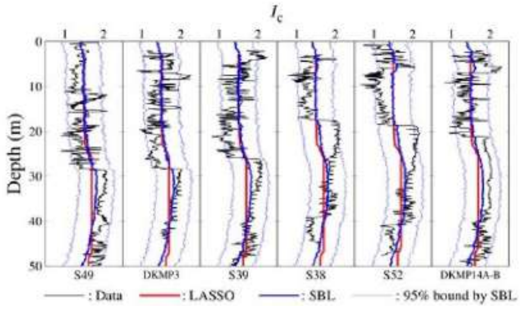
Effect of Densification on the Random Field Model Parameters of Liquefiable Soil and their Use in Estimating Spatially-Distributed Liquefaction-Induced Settlement by Armin W. Stuedlein, Taeho Bong, Jack Montgomery, Jianye Ching, Kok-Kwang Phoon



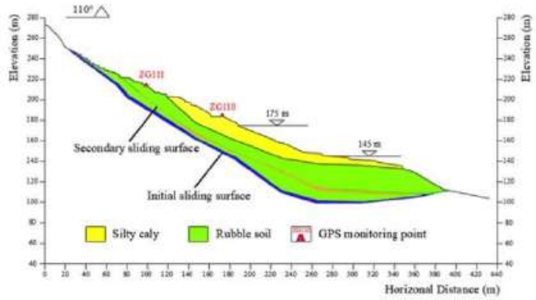
Multivariate Geostatistical Analysis of CPT Readings for Reliable 3D Subsoil Modeling of Heterogeneous Alluvial Deposits in Padania Plain by Diego Di Curzio, Giovanna Vessia



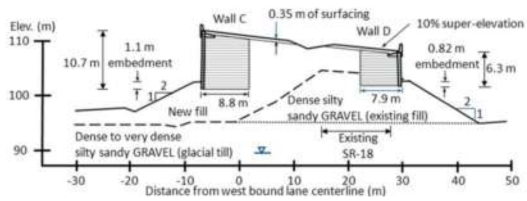
Case Histories on 2D/3D Underground Stratification Using Sparse Machine Learning by Takayuki Shuku, Jianye Ching



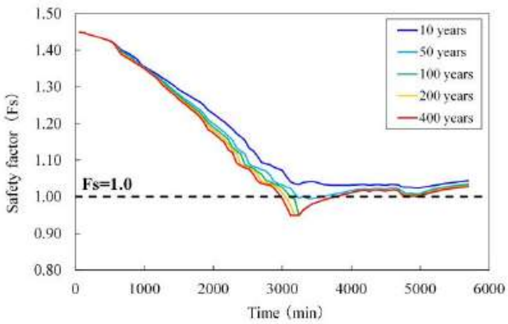
Application of Long Short-Term Memory Neural Network and Prophet Algorithm in Slope Displacement Prediction by Libin Tang, Yanbin Ma, Lin Wang, Wengang Zhang, Lining Zheng, Haijia Wen



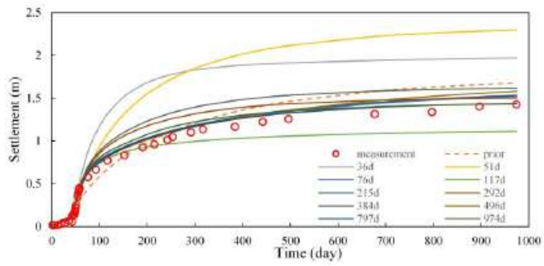
Reliability Assessment of Internal Stability Limit States for Two As-Built Geosynthetic MSE Walls by Richard J. Bathurst, Tony M. Allen



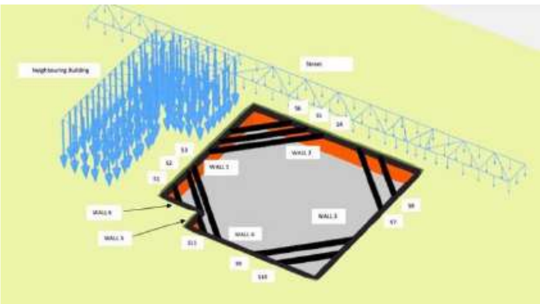
Case History of Risk Evaluation of Earth-Fill Dams Due to Heavy Rain by Toshifumi Shibata, Shin-ichi Nishimura, Tsubasa Tateishi, Shuichi Kuroda, Tomoo Kato, Kentaro Kuribayashi, Namihiko Tanaya



Settlement Predictions of a Trial Embankment on Ballina Clay by Shan Huang, Jinsong Huang, Richard Kelly, Cheng Zeng, Jiawei Xie



[Three-Dimensional Numerical Modeling of a Propped Cutter Soil Mix Retention System in Sand](#) by Woodie Theunissen, Owen Donald Fraser



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ITACET Foundation
Foundation for Education and Training on Tunnelling and Underground Space Use
Newsletter #34
December 2021

www.itacet.org/newsletter-34-december-2021

Κυκλοφόρησε το Newsletter του ITACET Foundation #34 Δεκεμβρίου 2021 με τα ακόλουθα περιεχόμενα:

- **President's address**
  - **Training session reports**
  - **MAITRISE DE L'EXCAVATION ET INSTABILITÉS EN MÉTHODE CONVENTIONNELLE, 05/09/2021, Paris, France**
  - **LUNCHTIME LECTURE SERIES - #9, 09/11/2021, Online** Specificity and Challenges of long tunnels at great depth Read more...
  - **LUNCHTIME LECTURE SERIES - #8,** 'Structural use of Permanent fibre Sprayed Concrete linings'. This episode featured 3 lectures: 1. PSCL report and selected references – Karl Gunnar Holter (WG12) 2. EN standard revision (Testing & Performance criteria) – Benoit de Rivaz (ITATECH & WG12)... Read more...
  - **LUNCHTIME LECTURE SERIES - #7, 21/09/2021, Online** Tunnel Refurbishment and was organised in collaboration with ITA WG6. Read more...
  - **LUNCHTIME LECTURE SERIES - #6, 13/07/2021, Online** "Into the Future" Read more...
- **Forthcoming sessions**
  - **ADVANCES IN DESIGN AND CONSTRUCTION OF TUNNELS, 01/02/2022, Pune, India.** To see the detailed programme and to register, please visit: https://www.itacet.org/session/advances-design-and-construction-tunnels
  - **SUSTAINABILITY IN UNDERGROUND DESIGN - PRACTICAL IMPLEMENTATIONS, 22/04/2022 to 23/04/2022, Copenhagen, Denmark.** To see the detailed programme and to register, please visit: https://www.itacet.org/session/sustainability-underground-design-practical-implementations
- **Other events in preparation**
  - India: **"Storm water drainage management"** - Date to be confirmed
  - India: **"Advances in tunnel design"** - Date to be confirmed
  - Brazil: **"Tunnelling 4.0"** - Date to be confirmed
  - Chile: **"Mechanized tunnelling and shafts"** – Date to be confirmed
- **Other news**

  SHINKUN-LA TUNNEL - WORKING IN THE HIMALAYAS (PART 1) Read more...

Finally, on behalf of all those at the ITACET Foundation, we would like to extend our Season's Greetings!

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DECEMBER 2021
itacus – for an urban underground future
ITACUS NEWSLETTER
THE OFFICIAL NEWSLETTER OF THE ITA COMMITTEE ON UNDERGROUND SPACE (ITACUS)

https://about.ita-aites.org/wg-committees/itacus

Κυκλοφόρησε το ITACUS NEWSLETTES Δεκεμβρίου 2021 με τα ακόλουθα περιεχόμενα:

- ITACUS partners with UNEP.
- New Board Members.
- Events.

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International Geosynthetics Society

Κυκλοφόρησε το IGS Newsletter της International Geosynthetics Society με τα ακόλουθα περιεχόμενα:

IGS NEWSLETTER – December 2021

Helping the world understand the appropriate value and use of geosynthetics

httpwww.geosyntheticssociety.org/newsletters

- Spotlight On Sustainable Initiatives In Geosynthetics READ MORE
- Did You Know...? The enduring durability of geosynthetics saves resources, time and costs. READ MORE
- IGS Foundation Funds Work Experience READ MORE

- Advisory Board Announced For 4th GeoAfrica READ MORE
- Kent von Maubeuge joins the IGS Foundation Board of Trustees READ MORE
- IGS CHILE Inaugural Educate The Educators Event In Chile READ MORE
- TC-H Workshop Success At Sardinia 2021 READ MORE
- My Engineer Life With… Han Wang READ MORE
- Upcoming Webinars
  - Limit State Design Framework For Geosynthetic Reinforced Structures, December 9, Presented by Dov Leshchinsky REGISTRATION INFORMATION
  - Ethics in Geosynthetics, December 16, Presented by Boyd Ramsey REGISTRATION INFORMATION
  - Soluciones de Taludes Reforzados en depósitos de residuos industriales (*Reinforced slope solutions in industrial waste deposits*), December 14, Presented by Nicolás Gonzalez REGISTRATION INFORMATION
  - Why is Geogrid so Difficult to Model in Finite Element Analysis?, December 21, Presented by Dr. Andrew Lees REGISTRATION INFORMATION
- Calendar of Events

https://www.sciencedirect.com/journal/geotextiles-and-geomembranes/vol/49/issue/6

Κυκλοφόρησε το Τεύχος 6 του Τόμου 49 (Δεκεμβρίου 2021) του Geotextiles and Geomembrabes της International Geosynthetics Society με τα ακόλουθα περιεχόμενα:

Χιονισμένα ελληνικά τοπία

Θεσσαλονίκη

Φλώρινα

Πάργα

Δράμα

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