Sistema Huautla that sits behind one of Skeleton Canyon, Mexico

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& ΓΕΩΤΕΧΝΙΚΗΣ
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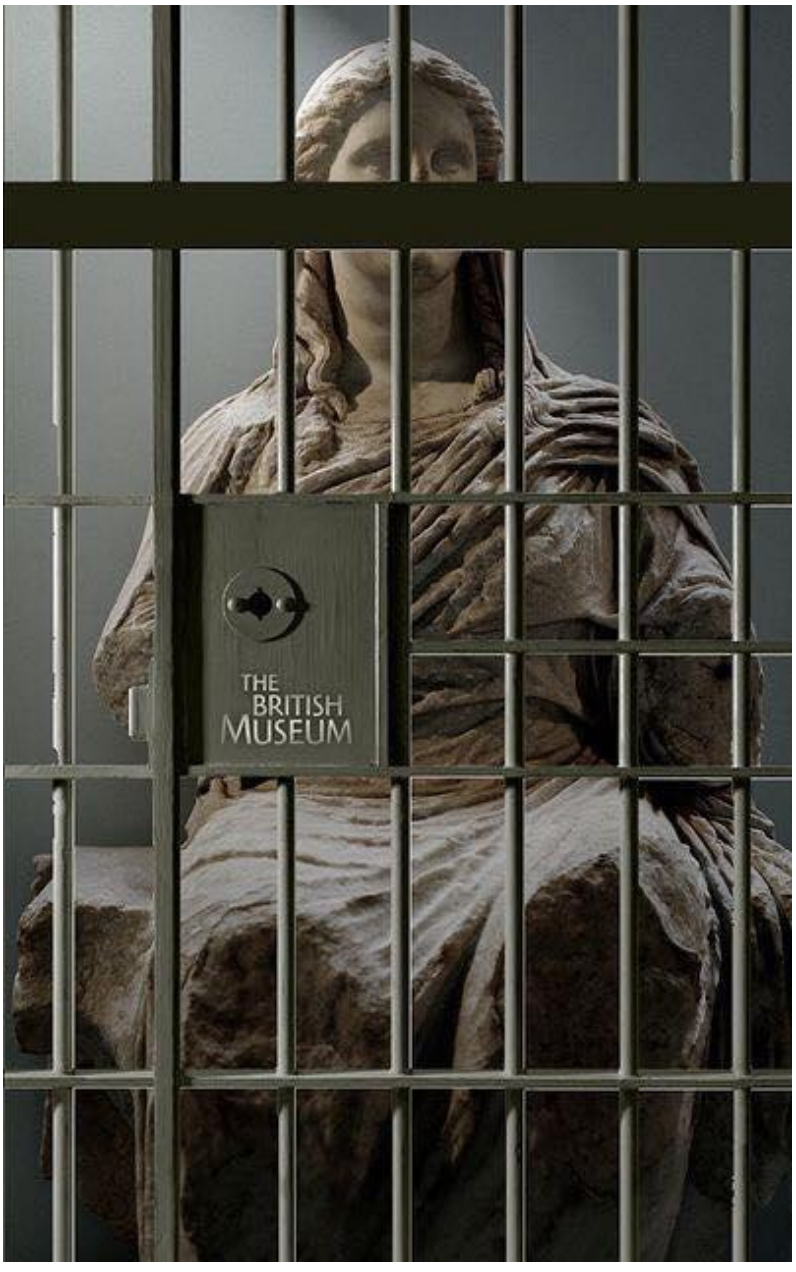

Αρ. 129 – ΑΥΓΟΥΣΤΟΣ 2019

SIMSG ISSMGE

International Society for Rock Mechanics
ISRM

Π Ε Ρ Ι Ε Χ Ο Μ Ε Ν Α

The mysterious Son Tra cave in southern Vietnam has formed naturally over thousands of years

Egypt

Αναμνήσεις διακοπών

Γίνετε Αρθρογράφοι του περιοδικού. Περιγράψτε έναν ενδιαφέροντα τόπο των διακοπών σας με τεχνικό, γεωτεχνικό και γεωλογικό ενδιαφέρον, πλαισιώνοντας την περιγραφή σας με φωτογραφίες.

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ΕΤΑΙΡΕΙΑ
ΕΔΑΦΟΜΗΧΑΝΙΚΗΣ
& ΓΕΩΤΕΧΝΙΚΗΣ
ΜΗΧΑΝΙΚΗΣ

Πρόσκληση σε Γενική Συνέλευση της ΕΕΕΕΓΜ και ΕΚΛΟΓΕΣ για την ανάδειξη νέας Εκτελεστικής και Εξελεγκτικής Επιτροπής

Αγαπητά μέλη,

Σας προσκαλούμε σε Γενική Συνέλευση της Ελληνικής Επιστημονικής Εταιρείας Εδαφομηχανικής και Γεωτεχνικής Μηχανικής και εκλογές για την ανάδειξη νέας Εκτελεστικής Επιτροπής και νέας Εξελεγκτικής Επιτροπής.

Η Γενική Συνέλευση θα διεξαχθεί το Σάββατο 28/9/2019 και ώρα 18:00 στο Αμφιθέατρο του Τμήματος Πολιτικών Μηχανικών στην Πολυτεχνειούπολη Ζωγράφου του Εθνικού Μετσόβιου Πολυτεχνείου στην Αθήνα. Εάν δεν παραστούν το ½ των μελών που έχουν εκπληρώσει τις ταμειακές τους υποχρεώσεις προς την ΕΕΕΕΓΜ η γενική συνέλευση θα επαναληφθεί την Παρασκευή 18/10/2019 και ώρα 18:00 στον ίδιο χώρο. Εάν σε αυτήν την ημερομηνία δεν παραστούν το ¼ των μελών που έχουν εκπληρώσει τις ταμειακές τους υποχρεώσεις προς την ΕΕΕΕΓΜ η γενική συνέλευση θα επαναληφθεί **την Πέμπτη 7/11/2019 ώρα 18:00 στο Αμφιθέατρο του Πολεμικού Μουσείου στην Αθήνα, οπότε θα διεξαχθεί με όσα μέλη της ΕΕΕΕΓΜ παραστούν και έχουν εκπληρώσει τις ταμειακές τους υποχρεώσεις προς την ΕΕΕΕΓΜ**.

Θέματα της γενικής συνέλευσης θα είναι:

1. Πεπραγμένα εκτελεστικής επιτροπής,
2. Οικονομικός απολογισμός,
3. Έκθεση εξελεγκτικής επιτροπής,
4. Εκλογές για νέα Εκτελεστική και Εξελεγκτική Επιτροπή.

Για την Εκτελεστική Επιτροπή της ΕΕΕΕΓΜ,

Ο Γενικός Γραμματέας,

Μ. Μπαρδάνης
Δρ Πολιτικός Μηχανικός

Πρόσκληση Υποβολής Υποψηφιοτήτων για την Εκτελεστική και την Εξελεγκτική Επιτροπή της ΕΕΕΕΓΜ

Αγαπητά μέλη,

Εν όψει της διεξαγωγής των εκλογών της ΕΕΕΕΓΜ για την ανάδειξη νέας Εκτελεστικής και Εξελεγκτικής Επιτροπής παρακαλούμε όποιο μέλος μας επιθυμεί να συμμετάσχει στις νέες επιτροπές να δηλώσει την υποψηφιότητά του μέχρι τις 23/9/2019 στην ηλεκτρονική διεύθυνση

mbardanis@edafos.gr

με σαφή αναφορά αν είναι υποψηφιότητα για την Εκτελεστική Επιτροπή ή την Εξελεγκτική Επιτροπή.

Για την Εκτελεστική Επιτροπή της ΕΕΕΕΓΜ,

Ο Γενικός Γραμματέας,

Μ. Μπαρδάνης
Δρ Πολιτικός Μηχανικός

Forensic Geotechnical Engineering Theory and Practice

Suzanne Lacasse*

Abstract Geotechnical engineers working with forensic evaluations must apply science and engineering within the rules and practice of the legal system, in order to be effective in representing reality and resolving conflicts. Such rules and practice will vary from country to country. The geotechnical work required for the documentation of forensic cases, however, should observe the same standards of quality in all countries. To provide the required assistance in the settlement of disputes, the engineer needs to combine high quality forensic investigations consistent with good science and engineering with an ability to clearly present the matters being disputed. This keynote lecture reviews the basic requirements of forensic geotechnical engineering. The technical forensic investigation requires collection of data, problem characterization, development of failure hypotheses, a realistic back analysis, observations in situ and in some cases performance monitoring, and most importantly quality control of not only the formal but also the technical aspects of the work. Two case histories of landslides are presented. The role of the geotechnical engineer as a forensic expert is highlighted, in particular in investigating damage and failure, evaluating the hazards and consequences, developing repair recommendations and preparing reports.

Keywords Forensic · Risk · Expert witness · Standard of care

2.1 Introduction

The practice of forensic geotechnical engineering is the application of geotechnical engineering to answer questions pertaining to a conflict in the legal system. The word forensic comes from Latin, where forensic means "of" or "before the forum". In Roman times, a criminal charge required presenting the case in a forum before a group of public individuals. The individual(s) with the best argument and delivery would determine the outcome of the case. The modern usages of the word forensic are a form of legal evidence and a category of public presentation (Lucia 2012).

The basic book on forensic engineering, "Forensic Geotechnical and Foundation Engineering" by Day (2011), interestingly, begins with the example of the sanctions in the legal code of construction of the great Babylonian King Hammurabi.[1] Two sanctions are illustrated in Fig. 2.1. Fortunately for our profession, the times and the legal codes have changed! Even more impressive, the code makers understood about risk, where Risk includes the Hazard and the Consequence components of an event.

[1] The Code of Hammurabi is a Babylonian law code dating back to about 1772 BC, and is one of the oldest writings in the world. The sixth Babylonian king, Hammurabi, enacted the code. The Code consists of 282 laws, with scaled punishments, adjusting "an eye for an eye, a tooth for a tooth" depending on social status (slave versus free man). Nearly one-half of the Code deals with matters of contract, establishing for example the wages to be paid to an ox driver or a surgeon. Other provisions set the terms of a transaction, for example, the liability of a builder for a house that collapses, or property that is damaged while left in the care of another.

Fig. 2.1 Sanctions in construction code in old Babylonia

Geotechnical engineers must apply science and engineering within the rules and practice of the legal system in order for their work to be effective in representing reality and resolving conflicts. Such rules and practice will vary from state to state and from country to country. However, the geotechnical work required for the documentation of forensic cases should observe the same standards of quality in all states and countries. To provide the required assistance in the settlement of disputes, the geotechnical engineer needs to combine high quality forensic investigations consistent with good science and engineering with an ability to clearly present the matters being disputed. The technical forensic investigation requires collection of data, problem characterization, development of failure hypotheses, a realistic back-analysis, field observations and in some cases performance monitoring, and most importantly quality control of not only the formal but also the technical aspects of the work.

Issues that have arisen requiring a forensic geotechnical analysis include for example (Day 2011): expansive soils, collapsible soils, settlement of shallow and deep compacted fills, moisture intrusion, corrosion, exposure to sulphates, runoff and drainage, pavement failures, slope instability, foundation failures, excavation failures, "differing" site conditions and underground pipeline failures.

The keynote lecture reviews the basic principles of forensic geotechnical engineering. Two case histories of slope instability, illustrating the importance of thorough and extensive geotechnical investigations and analyses, are presented. The first case study exemplifies how information from geological, geophysical and geotechnical investigations was integrated to establish a realistic model of the slope instability and to establish the trigger of the slide. This case ended up in court. The second case study tells an abridged story of the Storegga slide, one of the largest known underwater slides on earth. The role of the geotechnical engineer as a forensic expert is also highlighted, especially in preparing evidence and explaining the evidence in a clear manner.

2.1.1 The Practice of Forensic Engineering

The principles presented herein are based on the excellent review prepared by Lucia (2012) as part of the State-of-the-Art and State-of-Practice in Geotechnical Engineering GeoCongress in Oakland California USA.

In litigation, forensic engineering contains components of legal evidence and public presentation. The ability to present complicated technical facts to a layperson is the key to the outcome of a conflict. Unfortunately, facts are only a part of the resolution of a conflict. A poor presentation of the facts, in some case a distorted presentation of the facts,

can determine the outcome in a direction that does not agree with the engineering state-of-the-art.

The evaluation of a failure in the case of litigation has to in-

corporate the laws of science, the practice of engineering and the rules of evidence within a court system.

The forensic evaluation leads to an opinion on the cause of a failure and then to the responsibility for that cause. The technical evaluation leads to an assignment of responsibility to a party.

Engineers are typically ill-equipped to deal with the forensic process. Lawyers on the other hand are skilled at the presentation of facts and the resolution of conflicts.

2.1.2 Standard of Care

The engineer's compliance to the "standard of care" is usually one of the main issues in the case of litigation. ASFE (1993) stated that the standard of care is "that level of skill and competence ordinarily and contemporaneously demonstrated by professionals of the same discipline practising in the same locale and faced with the same or similar facts and circumstances". Parties in litigation therefore look for factors that contributed to the failure that are not representative of the standards met by other engineers (including sampling, in situ testing, laboratory testing, type of analyses, assumptions made, recommendations and performance monitoring). The courts do recognize that the standards and practice of engineering can vary over time.

Because there are never complete data to describe a site, the geotechnical engineer must interpolate between the limited data, apply assumptions to an analysis, make recommendations based on the interpolations and assumptions, and possibly include a monitoring programme. All of these steps require "substantial judgment" (Lucia 2012). While extreme cases do happen where causes and effects are obvious, most of the time the evaluation of the compliance with the Standard of Care by engineers fall into a grey area which very often results in a difference of opinions between experts. The standard of care is never written down in a manner that has gained universal acceptance, and is therefore always subject to debate. The combination of science and empiricism is considered the definition of the Standard of Care (Lucia 2012).

2.1.3 Expert Evidence

The forensic evaluation is intended to come to an opinion as to the factors that led to the failure and were ultimately responsible for the failure. Lucia (2012) reported that the USA Supreme Court ruled that the judge must ensure that any and all scientific testimony or evidence admitted is both relevant and reliable. The rules of admissibility are based on four criteria:

- When a scientific theory or technique is used in the development of an opinion, has the theory or opinion been tested?
- Has the scientific theory or theory been subjected to peer review and publication?
- Are there standards to control the application of the scientific theory or technique, and is there a known or potential error rate?
- Has the scientific theory or technique gained acceptance within the relevant scientific community?

Knowledge needs to be more than subjective belief or speculation, and must apply to a body of data or facts. Expert testimony does not need to be accurate with 100 % certainty. It is recognized that uncertainties exist in science and engineering.

2.1.4 Forensic Investigation and Litigation Process

The process begins when the parties realize that something different than assumed by the engineer has occurred. The question is, for example, whether the situation could have been foreseen, was knowable, was the result of an error in calculations, an omission, a negligent act on the part of the engineer, or a defect in construction caused by the contractor.

The burden of proof is on the plaintiff to demonstrate that the geotechnical engineer breeched the Standard of Care.

After forensic investigation has been completed by both sides of the litigation, the process of financially resolving the conflict begins. The decision of a settlement or a court case is generally a business decision, including the consideration of the costs yet to be incurred and the risk of losing. Lucia (2012) reported that 90 % of all the litigation cases he has been involved in have been settled prior to trial.

2.1.5 Case Studies Presented by Lucia (2012)

Lucia (2012) presented two examples of how the quality of the expert testimony can determine the litigation outcome. Central facts are summarized in Table 2.1.

The one lesson learned from these two case studies is that convincing a jury or a judge in a case involving technical matters depends on presenting the best facts supporting the case in such a way that a layperson can understand. No matter how correct a theory can be, a layperson will not be convinced unless he/she can understand its effects. Often an analogy, e.g. with a simple physical demonstration, will end up in being the most effective tool.

2.2 Case Study I

2.2.1 Finneidfjord Nearshore Shallow Landslide

2.2.1.1 Description of Case Study

In June 1996, a landslide of over 1 million m3 occurred just off the shoreline near the village of Finneidfjord in Northern Norway. During the Holocene, the marine deposits were exposed to freshwater flow and the leaching of salts resulted in very sensitive clays, called quick clays. The initial failure was believed to have occurred on the steepest slope of the foreshore (Janbu 1996; Longva et al. 2003; Gregersen 1999). Although 90 % of the slide was below sea level, its retrogressive nature meant that while encroaching 100–150 m inland, it destroyed 250–300 m of the Norwegian E6 highway and three residential houses (Figs. 2.2 and 2.3). Tragically four persons were killed, one in a car on the highway and three persons in one of the houses.

Geotechnical investigations prior and subsequent to the slide revealed large volumes of quick clay in the area. The Finneidfjord landslide developed along a well-defined plane. Based on seismic reflection and core data, the slip plane was identified as a stratigraphically weak, laminated, clay-rich bed (L'Heureux et al. 2012a, b; Steiner et al. 2012). The combined geophysical and geotechnical investigations indicated a complex, multi-stage failure.

A fill, from the excavated material for a nearby tunnelling project, was placed on the foreshore of the embankment just before the failure (Fig. 2.2). Blasting in the area had also taken place prior to the slide. In addition, intense rainfall had occurred in the days prior to the failure.

2.2.1.2 Post Failure Investigation

High-resolution swath bathymetry 2D reflection seismic profiles, a decimetre-resolution 3D seismic volume, numerous short cores, two long cores, and Free Fall cone penetrometer (FF-CPTu) profiles were used. The overlapping multi-beam bathymetric data sets were collected in the area between 2003 and 2009 (Vardy et al. 2012).

Table 2.1 Two examples of expert testimonies (case studies from Lucia 2012)

Case no./description	Outcome/comments	Ruling	Expert testimony
Ground settlement after trenching for utility installation. Owner demanded that the contractor remedy to the defect. Mediation failed, and the case ended in court	Contractor did place the fill according to contract specification, but the contract specification was inadequate. Should the engineer have reviewed the specification before start of the work?	Jury ruled in favour of contractor	Good facts, good presentation (simple demonstration of wet and dry densities) The technical issues were narrow and were made easily understandable to jury
Shallow failures (landslides) in open spaces in large housing complex. Homeowner association sued developer and contractor. Repair costs estimated by opposing experts to USD 2.5 and 25 M	Technical issues debated: – Extent and residual strength of colluvium; – Assumptions on water level; – Effect of earthquake loading; – Appropriate factor of safety (1.25, 1.5 or >1.5?)	Jury ruled USD 6.5 M compensation to be paid by developer and contractor to homeowners	Good facts, bad presentation by experts on both sides Jury members told afterwards that they did not understand what the experts on either side were talking about, and did not know who had the best facts

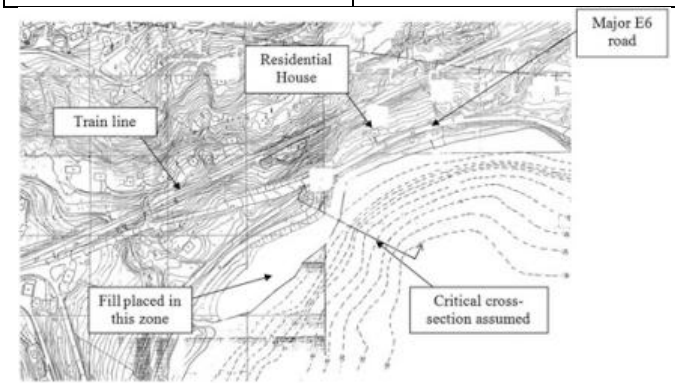

Fig. 2.2 Area prior to the Finneidfjord submarine slide (Gregersen 1999)

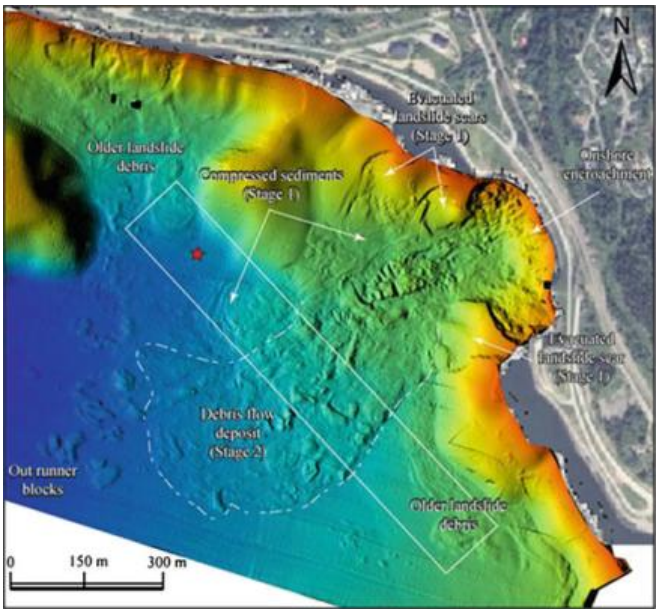

Fig. 2.3 Surface morphology for 1996 landslide imaged using high-resolution swath bathymetry (Vardy et al. 2012)

The geophysical data were complemented by geotechnical tests. Multi-sensor core logging (MSCL), detailed sedimentological description and X-ray imagery were used to describe structure, stratification and composition. The tests yielded magnetic susceptibility; density; P-wave velocity; porosity and water content; and grain size distribution. In situ geotechnical data were also acquired using free-fall CPTu. A total of 38 individual drops were done (Steiner et al. 2012).

Swath bathymetry images revealed evidence of mass wasting at several locations in the area. The landslide scars are 2–3 m high and devoid of debris, with the smooth surface interpreted as exposed slip planes. The planes correlate to a well-defined and high-amplitude reflection in high-resolution sub-bottom profiles (Fig. 2.4). This high-amplitude reflection was mapped throughout the fjord basin.

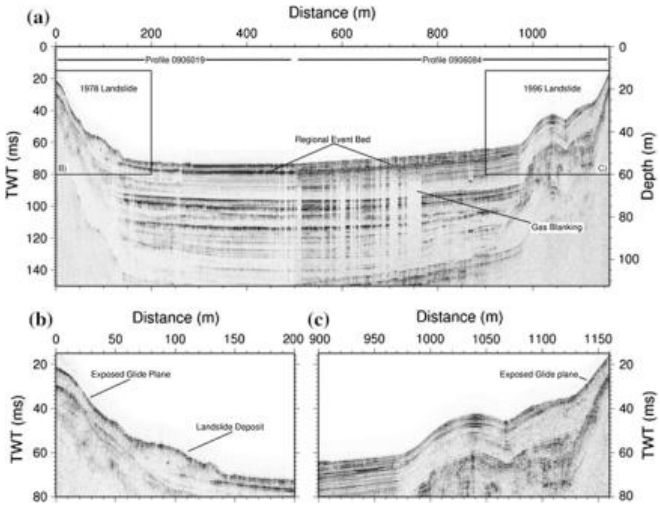

Fig. 2.4 Crossing TOPAS sub-bottom profiles (Vardy et al. 2012)

The bathymetry and seismic data and sediment cores showed that many of the underwater slides in the area were initiated along these "weak" beds (L'Heureux et al. 2012a). This includes the landslide of June 1996 (Fig. 2.3). Stage numbering in Fig. 2.3 refers to the phases of landslide development identified by Longva et al. (2003).

A two-stage mechanism describes the failure: the initial phase was a transitional movement of the foreshore slope;

the second stage involved blocky debris flow deposition as the head wall retrogressed to the shoreline and beyond.

Figure 2.5 shows the results of seismic and geotechnical investigations. The upper part of the figure shows seismic evidence for the slip plane (weaker layer) as a composite seismic reflection event that is partly eroded underneath landslide debris. The lower part of Fig. 2.5 shows the results from piston core, laboratory analyses and free-fall CPTu tests (L'Heureux et al. 2012a).

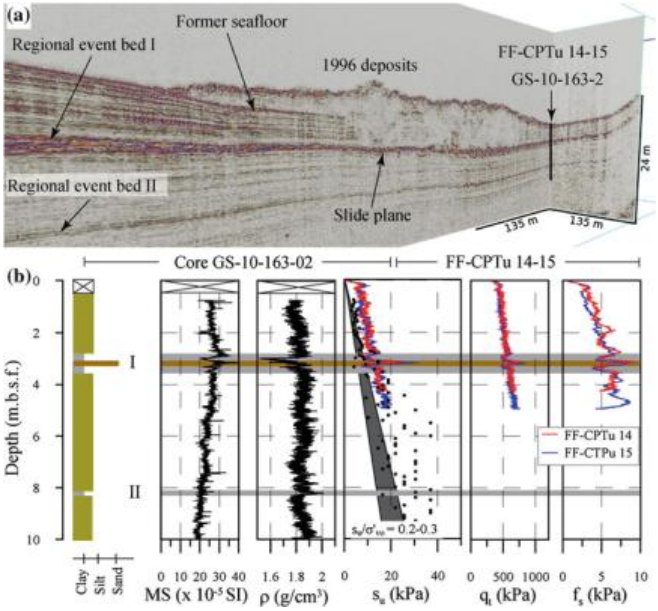

Fig. 2.5 Magnetic susceptibility (MS), gamma density (ρ), undrained shear strength (s_u), corrected cone resistance (q_t) and sleeve friction (f_s) in Finneidfjord (L'Heureux et al. 2012a)

The soil recovered in piston cores pushed adjacent to the slide deposit contained essentially homogeneous silty clays with shell fragments. The lithology changed suddenly at 2.9 m depth where a 45 cm thick bed, consisting of a 5 cm thick sand layer sandwiched between two distinct grey clay layers, 20 cm thick, was observed, with lows in both magnetic susceptibility and gamma density, and a very sharp peak in magnetic susceptibility and gamma density for the sandy layer. These features were confirmed by the free-fall CPTu tests. The water content for the laminated silty clay averaged 35 %.

In contrast, the water content was higher in the inferred failure zone, typically 45–65 %. Undrained shear strength (s_u) were typically lower (4–8 kPa), whereas the ratio of undrained shear strength to effective vertical stress (s_u/σ'_{vo}) fell between 0.2 and 0.3, which is a reasonable value for a normally consolidated clay. In contrast, the ratios s_u/σ'_{vo} for the background silt exceeded 0.3.

2.2.1.3 Deterministic and Probabilistic Analysis of Slope Stability

An initial deterministic stability analysis was run along the steepest cross section in the region surrounding where a fill had been placed (Fig. 2.2). There was consensus that the slide was initially triggered in this north-west region (Janbu 1996; Gregersen 1999; Longva et al. 2003), based on eye-witness accounts of waves, bubbles and whirls moving away from the shore and sea bottom investigations. The stability analysis used the Morgenstern-Price method with the SLOPE/W software. The initial deterministic failure mechanism investigated is shown in Fig. 2.6. For the properties and geometry assumed, the slope was found unstable with a safety factor of 0.95.

The initial deterministic analysis predicted that the slope cannot hold even though it was actually standing before the fill was placed. Geometrically lower slope steepness, higher soil strengths or model bias can explain such apparent inconsistency. Introducing the weaker layer seen on the geophys-

ical traces would bring the deterministic safety factor even lower. Cassidy et al. (2008) explored probabilistically the implications of the placement of the fill shown in Fig. 2.2. As shown in Fig. 2.7 and the top (black) curve in Fig. 2.8, increased layers of fill reduced the safety factor and the stability of the slope, with the mean calculable factor of safety against failure reducing from 0.95 to 0.91 and the probability of failure increasing to 80 %, as the fill increases to a height of 2.5 m.

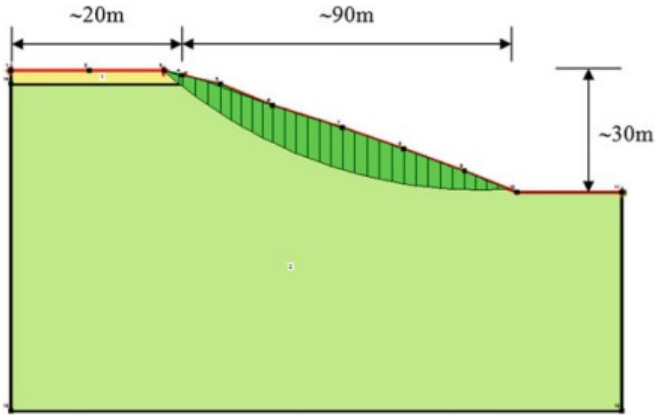

Fig. 2.6 Failure mechanism in deterministic analysis of Finneidfjord slide (Cassidy et al. 2008)

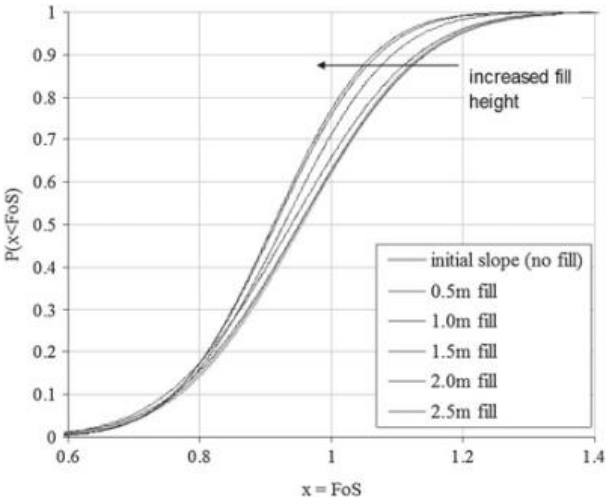

Fig. 2.7 Probability of exceeding factor of safety (FoS) of unity in probabilistic analysis for increased fill heights (Cassidy et al. 2008)

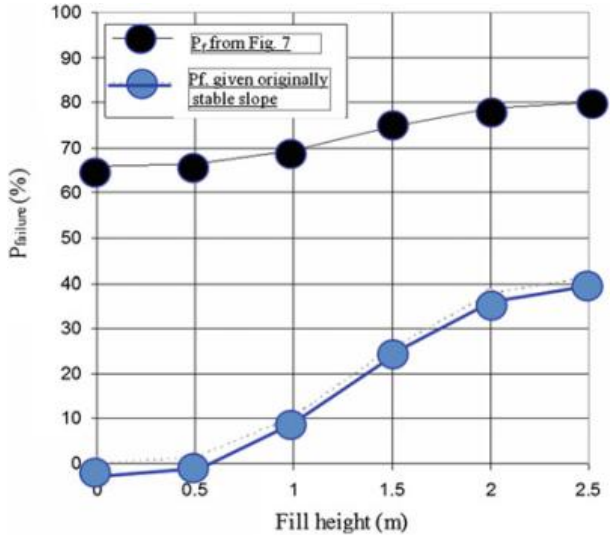

Fig. 2.8 Predicted probability of slope failure as a function of fill height (Lacasse et al. 2013)

Mean values for the probabilities of failure were studied as a function of varying fill height. However, it is known that the slope was standing under the condition of "no fill". Under the assumption that the placement of a fill is the only triggering mechanism, the probability of failure was again calculated.

The probability of slope failure given an initially stable slope was described as:

$$P(\mathrm{FoS}<1|\mathrm{FoS}_{\mathrm{nofill}}\geq 1)=1-\frac{P(\mathrm{FoS}\geq 1)}{P(\mathrm{FoS}_{\mathrm{nofill}}\geq 1)} \qquad (2.1)$$

where FoS is the factor of safety. These results of the probabilistic analyses are shown in Fig. 2.8. The analysis suggests that by including the known fact that the slope was originally stable, the probability of failure increases from close to 0 to just over 40 % with a 2.5 m high fill (blue curve in Fig. 2.8). The increase is not linear, with initially very little effect from adding more fill, but then also tapering off between the 2 and 2.5 m scenario results. The safety was therefore marginal (Pf ≈ 40 %) with the addition of a 2 m fill. Cassidy et al. (2008) also assessed the vulnerability and consequences of the Finneidfjord slide.

2.2.1.4 Possible Triggers for Finneidfjord Landslide

For the 1996 landslide near Finneidfjord, the identification of key reflections in the geophysical investigations indicated that the glide plane for the 1996 landslide may lie within the upper clay layer. This agreed with short cores higher up the foreshore slope that sample the exposed glide plane. In these cores, the sandy and lower clay layers were preserved. The upper clay was still present, but significantly thinner than observed in cores recovered adjacent to the slide (L'Heureux et al. 2012a). While the physical properties of the weaker material depended on the formation processes (i.e. rapid deposition of sensitive clay-rich material), it is unlikely that this alone made the layer weak enough to fail.

Post-depositional factors such as shallow gas and/or fluid flow and other external factors may have played a role in the triggering of the failure of the Finneidfjord slope. The following factors may have contributed as pre-conditioning factors to the landslide: excess pore pressure as a result of climatic and anthropogenic factors or the accumulation of free gas (Best et al. 2003; Morgan et al. 2009). The increase in overburden stress due to alongshore placement of fill material (Gregersen 1999) and the blasting from a nearby construction project (Woldeselassie 2012) could have acted as triggers. Recent numerical simulations showed that vibrations could have caused a slight increase in pore pressure (2–3 kPa) in the weaker silty clay layer. In the present analysis, the placement of 12,000–15,000 m^3 of fill from a nearby tunnelling project on the foreshore of the fjord was investigated as a possible trigger for the slide. Research studies are still ongoing on the possible triggers for the Finneidfjord landslide. Since the stability of the slope was initially marginal, several factors could have triggered the failure, or most probably, a combination of factors may have contributed to the failure.

The integration of geological and geophysical data was probably indispensable to construct a complete picture of all aspects influencing the conditions of the Finneidfjord slope, but also other instabilities in similar settings. The geophysics revealed the occurrence of a composite reflection of a thin sandy unit sandwiched between two clay units, which is new information. Similar identifications have been made in other fjords as the result of terrestrial quick-clay landslides in the catchment of the fjord, both in Norway and Canada (L'Heureux et al. 2012a). The stability analyses herein were done before all the geophysical information became available, and do not account for the presence of the effect of the weak layer. The weaker layer would change the shape of the slip plane, resulting in a lower safety factor and a higher probability of failure.

The jury involved in the litigation case concluded in disagreement with the placement of 12,000–15,000 m^3 of fill on the foreshore of the fjord being the trigger for the slide, and ruled that the cause of the failure could have been an increase in the pore pressure in the clay (at the time, the increase in pore pressure was still unexplained). The reason for this conclusion was the jury believing one of the experts more than the other one, probably because of a more forceful and more convincing presentation by this expert and the lawyer.

2.3 Case Study II

2.3.1 The Story of the Storegga Slide

The Storegga slide at the Ormen Lange site is one of the largest known submarine slides on earth. The head wall of the slide scar is 300 km long. About 3500 km^3 failed from the shelf edge, sliding out as far as 800 km in water depths as deep as 3000 m (Fig. 2.9). The failure started probably some 200 km downhill and crept rapidly upwards as the headwalls failed and slipped down towards the deep ocean floor. At the same time, the mass movement generated a huge tsunami that reached the shores of, among others, Norway, Scotland and the Shetland Islands. The sizable gas resources at Ormen Lange are located in the scar left by the giant underwater slide, beneath a relatively chaotic terrain created by the slide 8200 years ago.

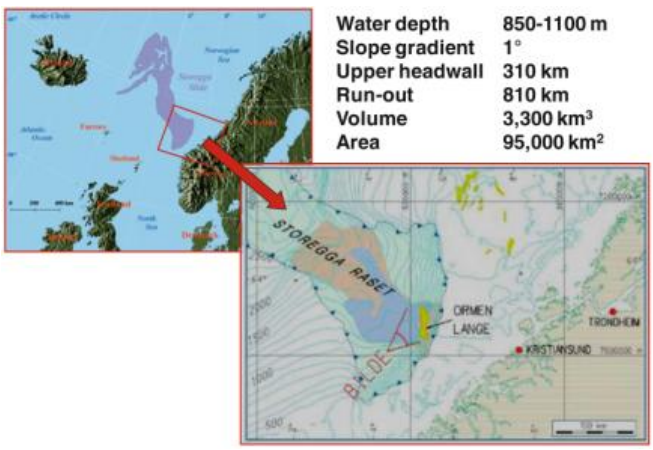

Fig. 2.9 The Storegga slide, 8200 years BP

The Storegga was not the subject of litigation, but it was the subject of a large, probably unprecedented, integrated study for the safe development of the deepwater gas field at the Ormen Lange site on the North Atlantic continental margin. In addition, the SEABED project was launched by the partners of the Ormen Lange field (Norsk Hydro ASA, A/S Norske Shell, Petoro AS, Statoil ASA, BP Norge AS and Esso Exploration and Production Norway AS) with the aim of improving the knowledge of the seafloor morphology, the shallow geology, and the potential hazards and risks associated with the area. The aim was to quantify the risks, reduce them as much as possible and ascertain any possible risk to third parties.

The project is an excellent example of the interweaving of research and practice and the cooperation of academia and industry. The reader should refer to Solheim et al. (2005a, b); Kvalstad et al. (2005a, b); Kvalstad (2007); Nadim et al. (2005) and the special issue of Marine and Petroleum Geology (2005) for a complete account of the slide and a summary of the studies by the parties involved.

The design questions that needed to be answered were: (1) Can a new large slide, capable of generating a tsunami, occur again, either due to natural processes or through the activities required for the exploitation of the field; and (2) Can smaller slides be triggered on the steep slopes created by the Storegga slide, and if so, would they endanger the planned offshore installations to recover the gas resources?

Based on the studies in the SEABED project, the triggering and sliding mechanics used the observed morphology and the geotechnical characteristics of the sediments. The average slope angle was only 0.6–0.7°. The geotechnical properties indicated shear strengths far above those required to explain a failure. However, the geophysical observations, especially seismic reflections profiles in the upper parts of the slide scar, provided strong indications that the failure developed retrogressively (Fig. 2.10). Using the retrogressive slide model as working hypothesis, several scenarios of sources of excess pore pressures were considered, including (1) earthquake-induced shear strain generating excess pore pressures, (2) melting of gas hydrates releasing methane gas and water, (3) shear strain induced contraction with pore pressure generation and strain-softening and (4) rapid deposition. The studies concluded that the most likely trigger was an earthquake destabilizing a locally steep slope in the lower part of the present slide scar. The retrogressive process continued up-slope until conditions improved with stronger layers, related to the consolidation of the shelf sediments during glacial times. Once the instability started, excess pore pressures already generated during rapid sedimentation under the last glaciation were an important contribution to the large slope failure (Bryn et al. 2005).

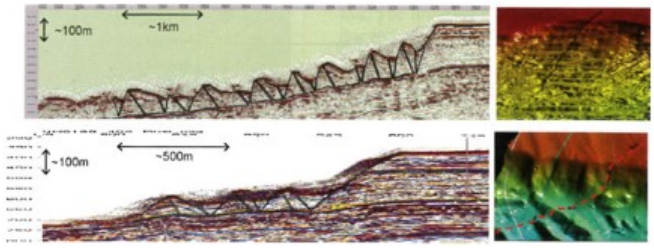

Fig. 2.10 Bathymetry and seismic profiles in the upper headwall at Ormen Lange and interpreted morphology of slide (Kvalstad et al. 2005a)

Excess pore pressures still exist at the site, as demonstrated by in situ monitoring (Strout and Tjelta 2005). The excess pore pressures recorded in several locations and at several stratigraphic levels support the depositional role in the Storegga failure proposed by Bryn et al. (2005).

Seismic studies by Bungum et al. (2005) showed that strong, isostatically induced earthquakes along the mapped faults at the site and stress transfer-induced earthquakes had occurred earlier. They also suggested that multiple strong earthquakes with extended duration most likely occurred and could be the potential trigger for the Storegga slope instability.

The tsunami generating potential of submarine slides is today widely recognized. Tsunami studies indicate that the field observations of tsunami run-up fitted will be the retrogressive slide model with velocity of 25–30 m/s, and short time lags of 15–20 s between individual slide blocks (Bondevik et al. 2005). The slide mass involved in the tsunami generation modelled was 2400 km^3.

Figure 2.11 illustrates the hemipelagic deposition of fine-grained sediments in the area of the Storegga slide. One of the pre-conditioning factors for sliding at Storegga was the presence of "weak layers". The stratigraphy and lateral extent of slide-prone deposits (i.e. the contourite drifts in Fig. 2.11) created "weaker" layers that increased the susceptibility of the slope to failure under earthquake loading. The con-tourites were controlled by the seabed topography and current direction. Deposition of soft marine clays is in fact still ongoing in the slide area.

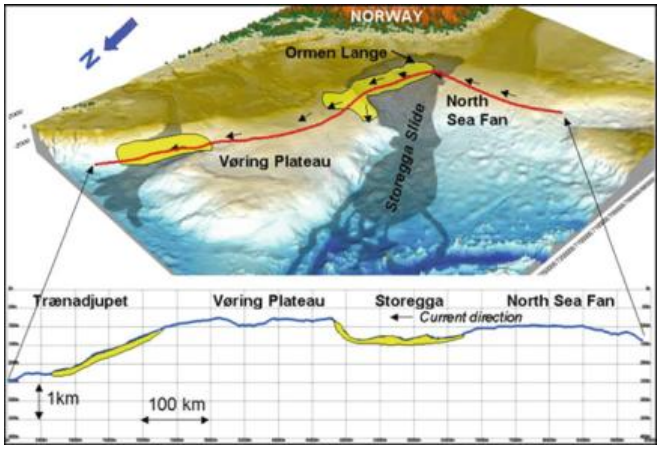

Fig. 2.11 Location of the main contouritic drifts (in *yellow*) (Bryn et al. 2005)

Figure 2.12 presents a schematic illustration to explain the sedimentation process leading to failure, which supports the hypothesis that major slides have occurred in the Storegga area on a semi-regular basis, related to the glacial/interglacial cyclicity.

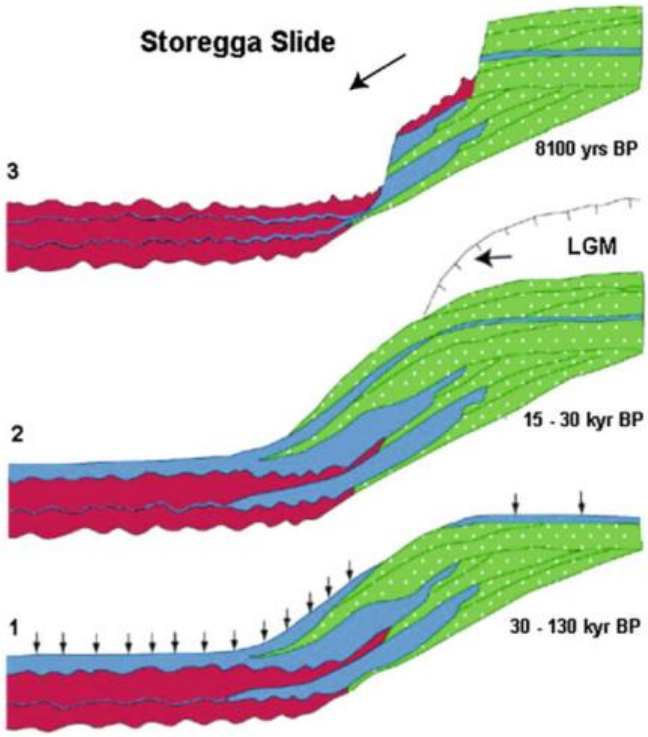

Fig. 2.12 Schematic of the deposition and sliding processes (*green* glacial sediments; *red* slide deposits; *blue* marine sediments) (Bryn et al. 2005)

The bottom illustration in Fig. 2.12 (denoted 1) gives the last interglacial with deposition of soft marine clays. The middle illustration (denoted 2) presents the last glacial maximum (LGM) with the ice at the shelf edge and deposition of glacial sediments. The top illustration (denoted 3) presents the topography after the Storegga slide. Dating (BP, before present) is given for each illustration. The illustration denoted 3 also shows two older slide scars that were filled with marine clays. The slip planes were found in seismically stratified units of hemi pelagic deposits and the thick infill of stratified sediments indicate a late glacial to early interglacial occurrence of slides (Bryn et al. 2005).

The soft fine-grained hemipelagic deposits were rapidly loaded by coarser glacial deposits during the short glaciations period. Excess pore pressures were a destabilizing factor. The hypothesis of strong earthquake shaking was retained to start the underwater slide. After the earthquake initiated the movement, the slide moved retrogressively by back-stepping up the slope where the pore pressures were already high. The mass movement was further facilitated by the release of support at the toe.

The stability of the present situation at Ormen Lange was evaluated by Kvalstad et al. (2005b). The conclusion was that an extremely strong earthquake would be the only realistic triggering mechanism for new submarine slides in the area. The annual probability of third-party damage was also investigated and found to be extremely low (Nadim et al. 2005). The project team therefore concluded that developing the Ormen Lange gas field could be done safely.

In general, the geohazards assessment should include the components in Fig. 2.13, incorporating in each assessment the uncertainties in the parameters (represented in Fig. 2.13 by probability distribution functions in red).

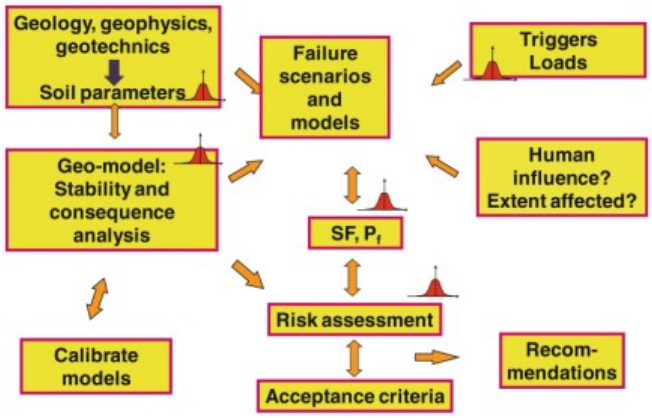

Fig. 2.13 Geohazards assessment methodology (*SF* factor of safety, P_f probability of failure)

2.3.1.1 The Role of the Expert in Forensic Engineering

Day (2011) presented a Recommended Practice for design professionals engaged as experts in the resolution of construction industry disputes prepared by the ASFE (1993). The 13-step guideline is summarized in Plate 2.1.

The author finds that the 13 guidelines are not specific to forensic engineering, but represents a good practice in all parts of geotechnical engineering. They speak of:

- avoiding conflicts of interest, placing integrity first;
- displaying professional demeanour, including respecting confidentiality;
- remaining within one's area of expertise;
- studying the facts and data in a thorough fashion and listening to other experts' opinions;
- striving for quality in all steps of the work;
- presenting findings in a concise and clear manner.

Any geotechnical engineering project, not only forensic engineering, needs to follow these guidelines.

Nevertheless, forensic engineering is complex. Engineers typically work in collaboration where they challenge each other to arrive at the best engineered solution or design pos-

sible. In litigation, collaboration is replaced by criticism, sometimes of well-supported professional opinions.

RECOMMENDED PRACTICE FOR DESIGN PROFESSIONALS ENGAGED AS EXPERTS IN THE RESOLUTION OF CONSTRUCTION INDUSTRY

1. The expert should avoid conflicts of interest and the appearance of conflicts of interest.
2. The expert should undertake an engagement only when qualified to do so, and should rely upon other qualified parties for assistance for assistance in matters which are beyond the expert's area of expertise.
3. The expert should consider other practitioners' opinions relative to the principles associated with the matter at issue.
4. The expert should obtain available information relative to the events in question in order to minimize reliance on assumptions, and should be prepared to explain any assumptions to the trier of facts.
5. The expert should evaluate reasonable explanations of causes and effects.

6. The expert should strive to ensure the integrity of tests and investigations conducted as part of the expert's services.
7. The expert should testify about professional standards of care only with knowledge of those standards which prevailed at the time in question, based upon reasonable enquiry.
8. The expert should use only those illustrative devices or presentations which simplify or clarify an issue.
9. The expert should maintain custody and control over whatever materials are entrusted to the expert's care.
10. The expert should respect confidentiality about an assignment.
11. The expert should refuse or terminate involvement in an engagement when fee is used in an attempt to compromise the expert's judgment.
12. The expert should refuse or terminate involvement in an engagement when the expert is not permitted to perform the investigation which the expert believes is necessary to render an opinion with a reasonable degree of certainty.
13. The expert should strive to maintain a professional demeanor and be dispassionate at all times.

Plate 2.1 Recommended practice for design professionals engaged as experts in the resolution of construction industry disputes (ASFE 1993; Day 2011)

Forensic engineering must therefore ally the best of science with the art of conflict resolution, all within a frame of important economical consequences for one of several parties. The requirements of forensic engineering are so demanding that not all geotechnical individuals can deliver good testimony. Specific qualities are required of forensic geotechnical engineers, including effective public speaking, a quick and logical mind and repartee, and exceptional pedagogical qualities, in addition to a thorough understanding of the subject of litigation.

An important responsibility is therefore to know when to say no to a request of expert opinion in the case of litigation.

2.4 Summary and Conclusions

The practice of forensic geotechnical engineering is the appli-

cation of geotechnical engineering to answer questions of interest in the context of litigation, where the engineering and legal professions are brought together to resolve the conflict on responsibility for a failure. The geotechnical engineer must apply science and engineering within the rules of the legal system, in order to present effective arguments.

Practitioners are naturally drawn to failures as they provide opportunities to verify calculation procedures, and increasing judgment and understanding on how and why the application of existing knowledge failed to achieve the intended result. The practice of forensic engineering is therefore one of the most interesting and most challenging tasks for a geotechnical engineer.

Forensic engineering is however paradoxical. Engineers typically work in collaboration where they challenge each other to conclude with the best engineered solution possible. In litigation, collaboration is replaced by criticism, sometimes of well-grounded professional opinions. Forensic engineering must therefore ally the best of science with the art of conflict resolution, all within a frame of important economical consequences for one of several parties.

When an expert presents its opinion on the cause or responsibility for a failure, the opinion must be well founded, and most importantly, presented in a way that the judge or jury can understand the technical issues in dispute (Lucia 2012). Simple demonstrations have proven to be very effective to explain physical and/or mechanical behaviour. Lucia (2012), based on 25 years of forensic geotechnical engineering experience, stated that while jurors and judges do their best to sort out the issues, the results can often be confusing. He suggested that settlement of the dispute prior to proceeding to trial is almost always the preferable outcome. In any case, a thoughtful, high quality forensic technical investigation consistent with good science and engineering combined with an ability to clearly present the matters being disputed will always aid in the settlement of the dispute or the outcome of a trial.

The requirements of forensic engineering are so demanding that not all geotechnical individuals should go into forensic engineering, and that specific qualities are required of forensic geotechnical engineers, including effective public elocution, a quick and logical mind and repartee, and exceptional pedagogical qualities, in addition to a thorough understanding of the subject of litigation.

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Twenty years of FRC tunnel final lining: Lessons learnt, design proposal and new development

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ABSTRACT: New guideline concerning the use of FRC pre-cast segment has been recently published to provide detail state of the art (ACI, FIB, ITA) and design proposal based on Model Code 2010. This paper will provide an overview of the lessons learnt and proposed design principle. The behaviour of fibre reinforced concrete is more than a simple superposition of the characteristics of the concrete matrix and the fibres. A unique concept of fibre has been developed which combined: high tensile strength + perfect anchorage (double hook) + ductile wire. This unique post cracking behaviour has been used to design very innovative solution. Three projects will be presented in this paper: the inner lining of Lee Tunnel in UK submit to internal pressure, the Jansen Mine shaft in Canada where shaft walls are slip formed and CIP tunnel in Turkey. All the design approach has been supported by a specific testing program.

1 INTRODUCTION

Steel fibres have been used to reinforce concrete since the early 1970s. Employed initially for applications such as industrial flooring, the 1980s saw the start of underground applications, in first shotcrete and then in both precast tunnel lining segments and Cast in Place Final lining.

However, a lack of regulation and standards hampered the spread of fibre-reinforced concrete for final tunnel linings. With the publication of international design guideline, the fib Model Code for Concrete Structures 2010 (Fib Bulletins), this obstacle has been overcome and designers are gaining confidence in working with fibres.

"This publication is targeted to be a source of information for updating existing codes or developing new codes for concrete structures. It specifically addresses non-traditional types of reinforcement, such as steel fibres, that have reached a status of recognition in previous years, with special attention being given to the use of fibre concrete in structural applications. At the same time, the Model Code is also intended to be an operational document for normal design situations and structures".

2 FRC BASIC PRINCIPLE

Steel fibres come in many different sizes, shapes and qualities with each having its own effect on the concrete behaviour and quality. The dosage of fibres needed to meet the desired structural performance will vary, depending on the characteristics of the fibre itself.

The behaviour of fibre reinforced concrete is more than a simple superposition of the characteristics of the concrete matrix and the fibres. To analyse the behaviour of this composite material, the way that the loads transfer between concrete matrix and fibre also must be taken into consideration.

For efficient load transfer, three conditions must be satisfied. There must be sufficient exchange surface, governed by the number of fibres, their length and diameter; the nature of the fibre-matrix interface allows for a proper load transfer; and the mechanical properties of the fibre such as Young's modulus, tensile strength and anchorage strength must allow the forces to be absorbed without breaking or excessively elongating the fibre.

To analyse the performances of fibre concretes, we must consider the combination of fibre and concrete as a composite material, which means integrating the transfer of the concrete matrix charges to the fibres network. This transfer is schematically shown in three distinct steps, identified on the following typical graph corresponding to (Asquapro technical booklet):

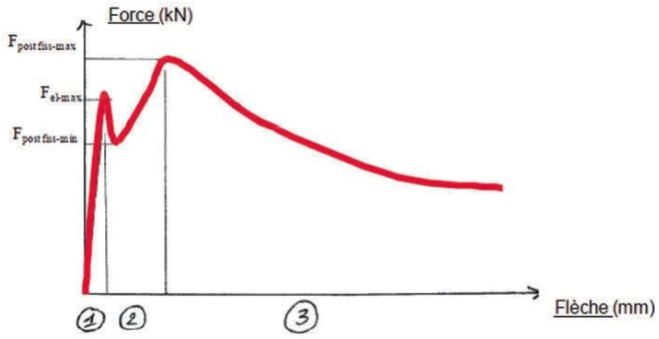

Figure 1. Schematically graph explaining the load transfer.

F_{elmax}: Maximum strength corresponding to the elastic limit of the fibre material $F_{post\ fissmin}$: Minimum force reached after cracking.

$F_{post\ fissmax}$: Maximum force reached after cracking, thanks to the absorption of forces by the fibres.

In the guideline published by Asquapro the following step are described:

Step 1: Adhesion over the entire length of the fibre during the phase of elastic strain, depending on:

- the speci!c exchange surface area (number, length, diameter of the !bres),
- the surface quality and thus the quality of the interface !bre/matrix,
- the compactness of the concrete matrix.

Step 2: Mobilization of the fibres right under the micro cracks, depending on:

- the elasticity modulus of the !bres,
- the number of !bres,
- the pro!le and orientation of the !bres,
- the quality of the interface !bre/matrix (adhesion),
- the compactness of the concrete matrix.

Step 3: Full mobilization of the anchoring, which may prove to be « total » or « sliding » (in support, « sliding » is sought-after):

- the shape of the anchoring,
- the possible sliding of the !bre in its sheath (interface quality and orientation !bre/cracks),
- the compactness of the concrete matrix,
- the number of !bres,
- the tensile strength of the !bre.

This transfer is efficient if the following three points are observed:

1. The exchange surface is adequate (number, length and diameter of fibres). For example, an inadequate number and length of Fibres can lead to fragile behaviour even if the characteristics of the interface and of the fibres are satisfactory. Indeed, the loads then not being sufficiently transferred to the fibre network, the crack may bypass the fibres and the break becomes fragile.

2. The quality of the fibre/matrix interface allows a good transfer of loads (anchoring of the fibre in the concrete). Although the number and characteristics of the fibres are satisfactory, an inadequate anchoring of the fibres (slipping, little compact interface) causes a fragile or pseudo-fragile break; the fibres are extracted from their concrete sheath without mechanical stress or with a stress widely below resistance capacity.

3. The intrinsic mechanical properties (Young's modulus and tensile strength) of the fibre allow to take up the stresses without a risk to break or to stretch too much. In contrast, a fibre with insufficient properties causes a fragile behaviour despite a large number of fibres and an effective interface. A fibre with a low Young's modulus leads to a large crack before the fibre take up the stresses. A fibre whose tensile strength is lower than the capacity of the anchoring, will break in its concrete sheath before being extracted.

3 FRC BASIC DESIGN PRINCIPLE

The existing technical guidelines/recommendations/codes provide the structural engineer advice on how to quantify the reinforcing properties of steel fibres based on the measured post crack tensile strength of SFRC.

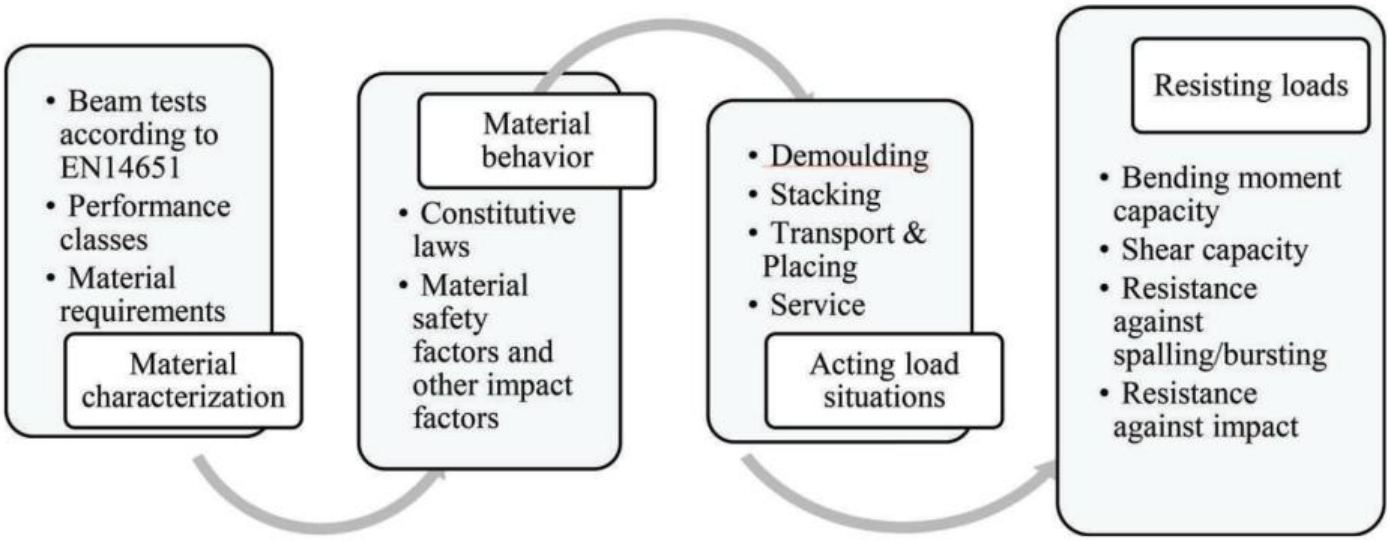

Figure 2. Design process.

In accordance with fib CEB-FIP Model Code 2010, the structural design of SFRC elements is based on the post-cracking residual tensile strength provided by the steel fibres.

Nominal values of the material properties can be determined by performing a flexural bending test: one of the most common refers to the EN 14651, which is based on a 3-point bending test on a notched beam.

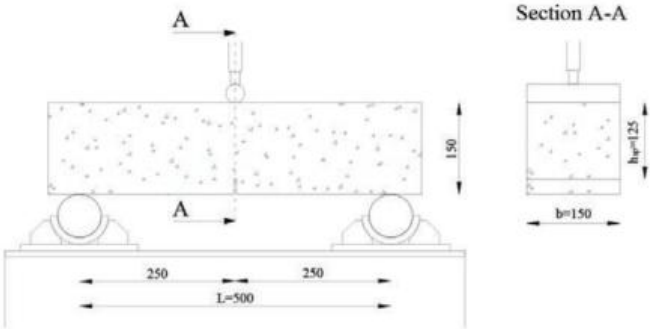

Figure 3. Flexural bending test set up.

The results can be expressed in terms of force (F) vs. Crack Mouth Opening Displacement (CMOD). In order to obtain reliable statistically results, a minimum of 6 beam tests are recommended. A typical F-CMOD curve for FRC is shown below (figure 4):

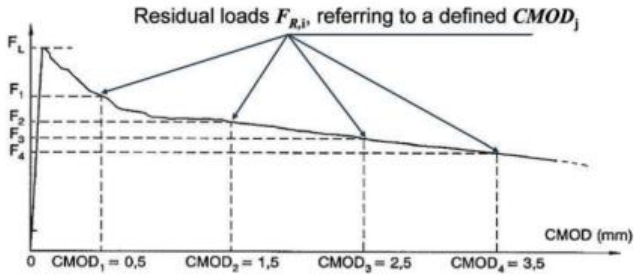

Figure 4. F-CMOD curve.

Parameters fR,j representing the residual flexural tensile strengths are evaluated from the FCMOD relationship according to the below equation (simplified linear elastic behaviour is assumed):

$$f_{R,j} = \frac{3F_{R,j}l}{2bh_{sp}^2} \quad (1)$$

Where:

fR,j is the residual flexural tensile strength corresponding to CMOD = CMODj
FR,j is the load measured during the test [kN]
l is the span length (distance between support) = 500 mm
b is the width of the beam= 150 mm
hsp is the distance between the tip of the notch and the top of the beam = 125 mm

From the above residual flexural tensile strengths, the characteristic values can be evaluated as follows:

$$f_{R,jk} = f_{R,jm} - k\ \sigma \qquad (2)$$

Where:

k is the Student's factor dependent on the number of the specimens σ is the standard deviation of the test results.

For the classification of the post-cracking strength of FRC, a linear elastic behaviour can be assumed, by considering the characteristic residual flexural strength values that are significant for serviceability (fR,1k) and ultimate (fR,3k) conditions.

In particular two parameters, namely:

- fR,1k Minimum value for SLS
- fR,3k Minimum value for ULS

The designer has to specify these two-minimum value.

Fibre reinforcement can substitute (also partially) conventional reinforcement at ultimate limit state, if the following relationships are fulfilled:

fR,1k / fLk > 0.4
fR,3k / fR,1k > 0.5

In FRC design process a specific constitutive model must be considered.

A typical constitutive model used for FRC, especially at low strain level, is the rigid plastic.

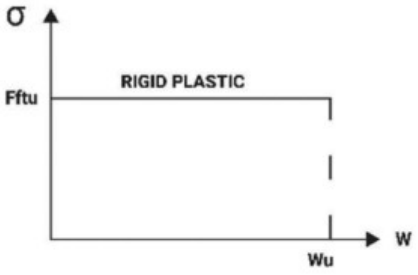

Figure 5. Simplified rigid-plastic constitutive relationship for FRC tensile behaviour.

4 FRC INNOVATIVE SOLUTION

4.1 *Precast segment*

Fibres can be used as reinforcement in precast concrete segment tunnel linings, either "fibre only" or in combination with conventional (bar) reinforcement, "combined solution". Its state of the art is defined by a large number of reference projects, where fibre reinforced concrete (FRC) segments have been used successfully. Projects using FRC segments report the following benefits of its use:

- Excellent durability
- Handling, installing damage and repairs are minimized
- Performance in the relevant ULS and SLS can be reliably demonstrated
- Overall manufacturing costs are lower than for conventionally reinforced concrete

This year there has been a flurry of additional guidance for fibre-reinforced segments: the American Concrete Institute's (ACI) Report of Design and Construction of Fibre-Reinforced Precast Concrete Tunnel Segments (ACI 544.7R-16); the International Tunnelling and Underground Space Association (ITA-AITES)'s Twenty Years of FRC Tunnel Segment Practice: Lessons Learned and Proposed Design Principles; BSI PAS8810:2016 Tunnel Design – Design of concrete segmental tunnel lining – Code of Practice; and ITAtech Guidance for Precast Fibre Reinforced Concrete Segments – Vol. 1 Design Aspects.

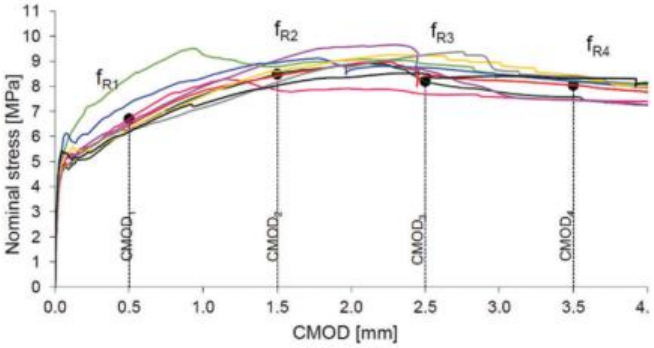

Figure 6. EN 14 651 test result with 4D 80/60BG.

A minimum performance class as C40/50 4c for the FRC as described by Model Code 2010 is recommended.

The use of fibre as Dramix 4D 80/60BG with the following properties are recommended as:

- l/D = 80
- Tensile strength > 1800 Mpa
- Optimum anchorage
- Glued for easy mixing and homogeneous reinforcement

The goal is to guaranty with the lowest dosage as possible a clear hardening post crack behaviour on beam and confirm on test scale 1 realized on segment.

4.2 *Permanent spray concrete lining*

Fibre reinforcement in the secondary linings of Sprayed Concrete Lining (SCL) designs, such as those used for Crossrail's station and platform tunnels, is also becoming more commonplace. And, as this article demonstrates, designers now have the option of fibre-reinforced concrete for cast-in-situ final linings too.

This application will be also structural reinforcement and could be design using the same process. Shorter fibre length 35mm and 0,55mm are commonly used to ensure with 20kg/m^3 already a network of 10 000ml/m^3. Glued and high tensile strength (> 1800Mpa) are recommended to meet project requirement. The typical Dramix 4D 65/35BG will be used for this application

4.3 *Cast in place final lining*

Bekaert spent five years developing the 5D fibre, trying many combinations of hook design and wire strengths to optimise the performance and the cost. The goal was to create a fibre that could be used in structural applications such as foundations slabs, rafts, suspended structures – and the final linings of tunnels.

Dramix 3D – the name for the Bekaert Maccaferri's original steel fibre – and the Dramix 4D, which uses higher-strength wire both work in the same way. The kinked ends provide ductility to the concrete by the slowly deforming as the wire is pulled out of the concrete. This is the mechanism that generates concrete ductility and post-crack strength.

The Dramix 5D fibre, with four kinks at either end rather than two or three respectively, actually works in a totally different way to its siblings the 3D and 4D: a revolution

rather than evolution. Rather than relying on the pull-out mechanism of the fibres to provide ductility, the 5D does not pull out but remains anchored, lengthening itself - as rebar does - to provide ductility.

The tensile strength of a steel fibre has to increase with the strength of its anchorage, otherwise it would snap causing the concrete to become more brittle. So, the 4D, for example, with its stronger anchorage is made of stronger wire than the 3D. The 5D uses wire with a tensile strength of 2.2N/mm^2 and ductility of more than 6 percent.

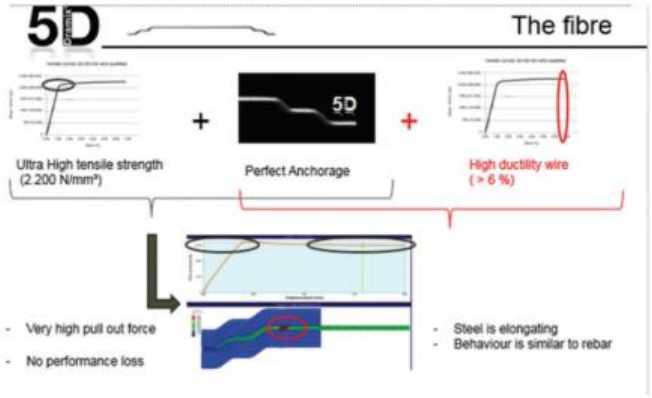

Figure 7. Dramix 5D a unique combination.

Very soon after the launch of Dramix 5D fibres in 2013, UnPS became one of the first designers to take advantage of the fibres' superior properties on London's multi-millionpound Lee Tunnel (Psomas et al 2014).

The decision to use the fibres was driven by the need to reduce crack widths – although it yielded other The Lee Tunnel in Beckton, London is the first tunnel to be nominated and to win the prestigious UK Concrete Society Award. Built as part of the Thames Tideway CSO project, the tunnel is lined with an innovative Dramix 5D steel fibre reinforced concrete.

Generally inner linings that are reinforced are done so when tension is induced into the lining. For example, hydro and/or sewer tunnels with a high internal head pressure places the inner lining into tension and therefore requires reinforcement to resist the tension in the lining and control cracking.

The design and fabrication of the traditional reinforcement in such a tunnel as the Lee Tunnel would have been a major logistical challenge to the construction team at the jobsite – an estimated 17000 tons of reinforcing bar would have had to have been delivered, stored, transported underground and fixed into position – with iron workers working at height off work platforms of some description in what is technically a confined space and consuming valuable time within the program. One may argue that this operation would have been undertaken as the concrete pours progressed. However, the logistics of moving the high volume of bar reinforcement through the tunnel is a high-risk operation and places additional numbers of operatives and equipment underground and in the immediate vicinity of the concrete works.

MVB JV decided after much research over the last year or so to use the relatively new 5D Dramix steel fibre: this has a double hooked end and a much higher wire tensile strength than the 3D standard Dramix steel fibres previously used. These changes to the fibre geometry and technical characteristics provides the 5D fibre concrete with strain hardening in bending properties that enabled the designer (MS UnPS) of the secondary inner lining to verify the governing design situation for structural crack control.

All hook ended steel fibres, when under loading tend to deform/straighten out by pulling out of the concrete and so a controlled deformation occurs providing the energy absorption that can be measured by beam and plate testing, however the Dramix 5D steel fibre has these double hooked ends and these remain anchored in the concrete, the wire itself is some 2300MPa and this elongates some 7% just as traditional reinforcement behaves and this is what provides the steel fibre concrete element with the bending hardening properties and therefore provide designers with more opportunities to design steel fibre concrete structures both underground and surface structures.

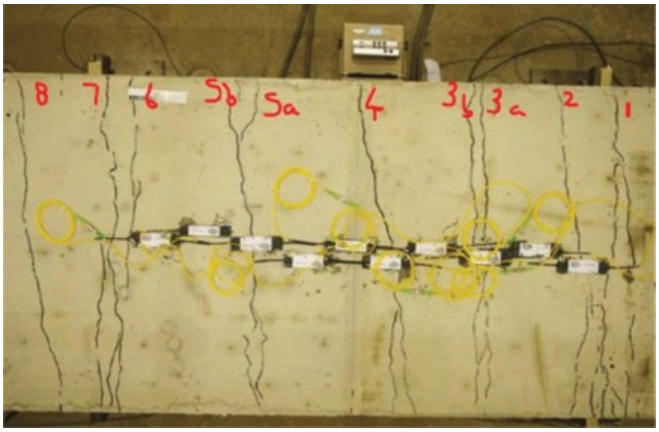

Figure 8. BRE testing – multi cracking.

Figure 9. BRE testing – multi cracking over loading span 1.645m.

By researching on a large scale seen above and by careful examination and analysis of the results the Designer (MS UnPS) & MVB JV decided to replace the standard traditional reinforcement with the 5D Dramix steel wire fibres – so removing some 17000 tons of bar with >2000 tons of the 5D Dramix steel fibre and eliminating the very large and difficult logistical challenge that would have been placed before the contractors underground team.

However, before work could start underground with the secondary lining, much work was required to establish a suitable concrete mix design that would pump up to 250m and virtually self-compact itself in the enclosed shutter within the tunnel lining. The concrete mix design (and final refinement) has taken almost 6 months to be able to work well and maintain its performance after pumping such distances and while not a great distance compared to some projects it still has to be able to almost self-compact with very little vibration. It isn't designed as a self-compacting concrete – the contractor wished to avoid any risk of the steel fibre segregating, fibre distribution was checked on

the early pours and the indications showed there is excellent fibre distribution based on retrieved cores from the first pours in the works that suggest that the two principal orientations are in hoop and longitudinal direction, further analysis is being considered using X-ray photography.

The Riva Tunnel is another underground project to use the new Dramix 5D series fibres which can be used to create a material which has a far greater residual strength after cracking than other fibre-reinforced concretes, behaving more like traditionally reinforced concrete. In each of the three cases, designers and constructors faced challenges around constructability or durability – or both – of the final lining which have been solved with the help of this new breed of fibre.

When contractor IC Ictas-Astaldi came to fix the rebar for the secondary lining of the Riva Tunnel in Istanbul, it ran into some problems. The 22m-wide tunnel required reinforcing bars up to 12m long to be fixed; this was proving difficult to do, introducing safety risks and causing damage to the sheet waterproofing membrane which sits between primary and secondary lining.

The solution was a bold and unusual one for Turkey: using fibre-reinforced concrete to create the permanent secondary lining. Following careful evaluation and tests at Istanbul Technical University, designer EMAY International was able to demonstrate that by using high-performance steel fibres a fibre-reinforced concrete lining would be just as good as one reinforced using steel reinforcing bars.

The latest project to make use of 5D's characteristics is the Jansen project, the development of a new potash mine in east-central Saskatchewan, Canada. Contractor DMC Mining is slipforming the walls of two 1000m-deep shafts, aiming for production rates of 3m a day.

The future will see more use of 5D fibres in the permanent linings of tunnels and shafts. Several projects are already being designed using the fibre and others are considering its use as an alternative to traditional reinforcement for the final lining. Other underground applications have included track slab inside rail tunnels and free-spanning slabs in car parks.

5 CONCLUSION

The possibility of adopting fibre reinforced concrete, without traditional steel reinforcement for precast tunnel segments and cast in place final lining is herein analysed, with reference to test scale 1 and some project realized worldwide.

A minimum performance class or the FRC as described by Model Code 2010 should be defined according to the project requirement.

Fibre materials with a Young's modulus which is significantly affected by:

- time and/or
- thermo-hydrometrical phenomena

are not covered by this Model Code

Steel fibres are suitable reinforcement material for concrete because they possess a thermal expansion coefficient equal to that of concrete, their Young's Modulus is at least 5 times higher than that of concrete and the creep of regular carbon steel fibres can only occur above 370 °C (ISO 13270).

FRC has proven over the years to be a reliable construction material. State of the art concerning steel fibre is complete and validate by the scientific community through many standards and guideline. After 30 years of experience, the first Rilem design guidelines for steel fibre concrete were edited in October 2003 and Model Code 2010 published by fib in 21012 is now recognized as the reference design standard.

Nevertheless, in order to obtain the desired results, it is worth noting the necessity to develop an accurate study of the material, i.e. the fibre typology suitable to a peculiar matrix.

In order to optimize the FRC solution some investigation should be conducted at early age of the design process with all actors involved in the project.

There is no good and bad fibre but just the right fibre for the right application using the relevant testing method to determine engineering properties and for quality control.

The use of the finished material should be considered along with the test and performance criteria, post-crack behaviour, match crack widths and deformation in the test to expectations in the project and durability requirement.

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Tunnels and Underground Cities: Engineering and Innovation meet Archaeology, Architecture and Art – Peila, Viggiani & Celestino (Eds)

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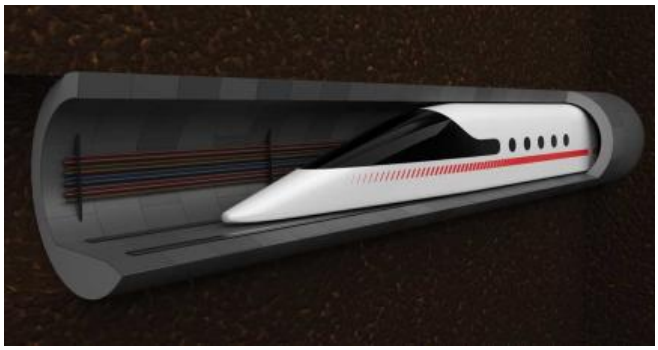
Emerging Technologies in Tunnel Construction



The tunnel construction market is one of constant evolution – and sometimes revolution. Dating back to ancient civilizations through today's modern marvels, designers and constructors have kept pace with the needs of society by applying new technology to an ancient craft. The 19th century saw the advent of subaqueous tunnels (Thames Tunnel) and drill-and-blast tunnels (Hoosac Tunnel), that changed the way we travel, while the 20th century ushered in a whole new era of underground construction with the introduction of Tunnel Boring Machines.

Today, we are seeing TBMs that are dealing with a broader range of ground conditions, with larger diameters and under greater pressures. These machines are opening doors for projects that may not have been feasible in the past, improving the quality of our infrastructure and contributing to a sustainable urban environment.

To get a sense of the impact of technology in today's tunnel construction market and where it is headed, we talked with HNTB's Mike Wongkaew and Tony Bauer. Specifically, the topics of large-diameter TBM tunneling, hyperloop and tunnel lining design were discussed.

TBM: There has been a trend toward large bore tunnels internationally and we are now seeing it in the United States – Seattle, San Jose, Miami, Hampton Roads. Why are owners becoming more receptive to the idea of using large-diameter TBMs?

Wongkaew: With increasing numbers of successful projects and the availability of experienced suppliers, contractors and consultants internationally and in the United States, owners begin to feel more comfortable with large bore and consider it among the feasible alternatives that could address their infrastructure needs. Large bore also provides several unique advantages over twin bores.

TBM: What are the challenges associated with building and using large-bore TBMs?

Wongkaew: From the designer's perspective, portal site constraints and logistics are key physical challenges for building large bore tunnels. Access to the site for TBM and material delivery, power requirements, muck processing (especially for slurry TBM) and hauling requirements are important factors that must be considered in portal area planning. Additional challenges include exponential increase in cutterhead torque requirements, increased cutting tool wear and replacement, large variation of pressure across the tunnel face and large perimeter of the annular gap between the excavated diameter and the lining extrados. The last two challenges must be well managed to mitigate the risk of settlement impacts.

Challenges for using large bore TBM include increased tunnel profile depth at the portal to address the buoyancy effect and under existing infrastructures to manage settlement impact risk, and increased minimum alignment radius to accommodate TBM articulation and lining installation. An additional challenge, although this could be viewed as opportunity, is optimization of the space utilization within the large bore as void spaces may require additional ventilation and fire and life safety consideration.

TBM: What technological improvements have been made to increase the practicality of large TBMs

Wongkaew: Improvements are continuing to be made to address some of technical challenges discussed above. For example, TBM manufacturers have developed methods for replacing cutting tools under atmospheric pressure, improving mixing of the muck within the chamber, addressing abrupt or large change in the face pressure across the height of the chamber, backfilling and lubricating the shield gap, and for rapidly filling the annular gap between the liner and the excavated ground. These improvements, among many others, mitigate several key risks of large TBM tunneling and demonstrate how TBM's advanced controls add to the machine's ability to control the ground settlement impacts on large bore projects.

TBM: What are the advantages of large bores vs. twin bores?

Wongkaew: There are several advantages of large bores. For example, WSDOT and the City of Seattle saw the benefits of reducing the SR 99 tunnel project footprint as compared to two smaller bores and reducing the surface impacts and disruption as compared to surface and elevated alternatives. For mass transit projects, VTA in San Jose and another transit agency in the Pacific Northwest began exploring a large bore option because of its ability to accommodate two tracks and station platform(s) inside the bore. This would reduce the need for cut-and-cover station construction including impacts on streets, traffic and utilities which can be very disruptive to communities and businesses situated within dense urban areas. The continuous space within the large bore also increases flexibility in locating stations and helps identifying station locations and track crossovers readily along the tunnel alignment, which enhances user experience and operational reliability.

TBM: How does a single large bore compare to twin bore when it comes to cost of construction? Cost of maintenance?

Wongkaew: The cost of tunnel construction is higher for large bore compared to twin bores as the TBM cost, tunnel liner and muck handling and disposal costs are greater; however, for many projects tunneling is not the only major cost items. For underground mass transit projects in urban centers, as an example, the increased cost of large bore tunneling would be offset by the reduction in station and crossover construction, right of way acquisition, and surface disruption mitigation costs, adding to an overall project schedule reliability. It is difficult to provide a generalized conclusion as each project is unique, but for several projects that HNTB have been involved with, the large bore can be cost competitive to twin bore when all cost aspect of the project is thoroughly analyzed.

We do not yet have enough case histories of life cycle costs, but similar tradeoffs could be foreseen. Large bores would have more and larger elements to be maintained; however, inspection and maintenance access in large bores would be easier and less impeded by space constrains and generally feasible during revenue service hours for large parts of the tunnel structure.

TBM: What are some of the safety considerations of large bore tunnels?

Wongkaew: The larger cross section of large bores means larger volume of air will need to be ventilated during construction, normal operating condition and emergency (this aspect could be controlled by guideway cross-section area control). Heightened attention is also needed in the areas of fall protection, ladders and stairs, scaffolding, hoisting and conveyors, etc., for the construction of sizable interior structures inside the large bores. Large bore also increases the importance of face pressure control, muck volume balancing, shield gap grouting and annular gap grouting for ground movement and settlement risk management.

TBM: How do you see the future of large bore tunneling in the US and internationally? Will it continue to grow?

Wongkaew: We expect the demand for large bores to continue to grow as the technology matures and owners find innovative ways to utilize the large underground space.

TBM: What are some areas that perhaps can be improved on to increase the effectiveness of large TBMs?

Wongkaew: Muck handling and ring erection continue to be two slow steps in the mining cycle that limit the production rate of TBM tunneling.

TBM: What is the current status of hyperloop development in the US and internationally? Are we close to building routes?

Bauer: Hyperloop is an emerging technology that is still in the early development phases; however, it is closer to reality than many believe. There are several projects in various stages of development within the United States – St. Louis to Kansas City and the Colorado Front Range being the most prominent.

Obviously, there is no operating commercial hyperloop system to use as a precedent. Therefore, the challenge for each of these projects will be to demonstrate to government agencies that the technology has achieved a level of technical maturity sufficient to justify the investment of public funds. If they cannot demonstrate this level of development, the hyperloop companies will be compelled to rely on private financing or government grants to build the first systems.

TBM: Tunneling is not necessarily needed for hyperloop. What do you envision as the role of tunneling in hyperloop development? What impact will it have on the tunneling industry?

Bauer: The physics of high-speed travel – whether with a hyperloop, high-speed train, or airplane – require straight routes to maintain acceleration forces which are tolerable to passengers. Passenger hyperloop systems would likely connect densely populated cities and there are not many transportation corridors available to build a new transportation network. The practicalities of designing the infrastructure for hyperloop in an urban setting will necessitate going underground. The tunneling industry should encourage the development of hyperloop systems because it will result in more underground construction all around.

TBM: What special considerations would be needed for tunneling for hyperloop vs. typical water or transportation tunnels?

Bauer: Current construction and design practices can be used for hyperloop tunnels. If the industry can continue to mechanize, standardize and automate the tunnel construction methods with the goal of driving costs lower, this can unlock other projects which have previously been considered uneconomical.

TBM: What advantages does tunneling have for hyperloop development vs. surface or aerial alignments?

Bauer: Using tunneling for hyperloop infrastructure will lead to simpler alignments, faster speeds, shorter travel times, and less disruption to the communities around the project.

TBM: What areas of tunneling are ripe for improvement?

Wongkaew: In the near term, I would like to see more research into fiber reinforcing. Steel fibers have been used in segments for quite some time. However, we could use more research to ensure fibers are consistently and uniformly distributed in the precast segments. Macrosynthetic fibers may help in this regard as we will get more fiber count for the same cost. However, we need more case history and research done to confirm the performance of macrosynthetic fiber reinforced segments for this technology to be widely accepted.

We also would like to see TBM technologies that can deal with manmade steel obstruction such as steel piles and tieback ground anchors. These are growing problem for TBM tunneling in dense urban areas.

TBM: A lot of talk recently has focused on the construction cost of tunneling, as well as production rates. What can we do to make tunneling less expensive? How can we increase production?

Wongkaew: Muck handling and disposal continue to be a major cost factor for TBM tunneling. We applaud the effort by Elon Musk and others to find ways to reuse the muck.

Ring erection is another step in the mining process that takes time and human intervention. We expect to see more innovation in this area including the use of boltless segments that could simplify automation of ring erection.

TBM: What are some of the issues related to liner design? Speed to produce? Ease of installation? Cost? Performance?

Wongkaew: Corner spalling of lining segments remains an issue that has not been fully eradicated. It is challenging to provide proper reinforcing in the corners. The use of steel fiber reinforcement is helping but only when proper distribution of fibers is achieved. We would benefit from more research and best practice guidance on how to ensure proper distribution of fibers in the lining segments.

I also personally would like to see more standardization of tunnel lining segment as the sizes, thickness and details of the segments now vary from project to project often unnecessarily. The bridge industry developed standard precast girder sections quite some time ago and everyone in the ecosystem has benefited from it, including owners, contractors, precasters and designers. Standardization has the potential to reduce the cost and improve the quality of lining segments.

TBM: How have liner designs changed to allow tunneling under high pressure (Lake Mead, Delaware Aqueduct)?

Wongkaew: Most of the challenges are in the TBM tunneling process, e.g. advance grouting to reduce permeability and inflow, maintaining suitable active face support, muck conditioning and hyperbaric intervention. The liner design

approach itself has not changed significantly to allow tunneling under high pressure. Suitable gaskets for high pressure application have been available for quite some time. The tunnel liners need to be designed for the concentrated reaction forces from the compressed gaskets and for the relatively high external ground loads. Some projects opted for the use of double gaskets for redundancy.

TBM: How have liner designs changed to allow tunneling in seismic areas?

Wongkaew: We see more utilization of advanced methods of analysis, such as nonlinear time history analysis and three-dimensional analysis, to increase our understanding of the seismic load effects in the liner and how the liner would behave during seismic events. We also see increased use of double gaskets or combination gasket (EPDM and hydrophilic) in seismic areas to provide redundancy.

Traditionally, gaskets have been tested under static condition. For SR 99 tunnel in Seattle, the gasket was also tested under dynamic loading-unloading condition to better understand the potential adverse memory effect of the gasket material and to confirm water tightness under seismic condition. For Istanbul, special rings and expansion joint details were provided at geologic transitions between rock and soft ground in addition to the interfaces with stiffer cut and cover structures.

(Tunnel Business Magazine - TBM Staff, August 27, 2019, https://tunnelingonline.com/emerging-technologies-in-tunnel-construction)

Σημείωση: HNTB Corporation is an employee-owned infrastructure solutions firm serving public and private owners and contractors

Anthony Bauer, PE, is HNTB Corp.'s national tunnel practice operations manager-West. He is based in Los Angeles and supports tunneling projects throughout the West Coast and nationally. Bauer's high-profile, complex underground project expertise includes working with clients such as Virgin Hyperloop One, Valley Transportation Authority, California High-Speed Rail, London Underground, Sound Transit (Seattle), Washington Metro and others.

Mike Wongkaew, Ph.D., PE, SE, PMP, is HNTB Corp.'s national tunnel practice lead-Northwest and associate vice president. He is based in Bellevue, Washington, and oversees all tunneling work on the Sound Transit West Seattle and Ballard Link Extension Project, as well as projects across the nation. Previously, he served as chief tunnel engineer for research and development of an innovative underground transportation system.

Follow the Yellow Book road over the FIDIC rainbow to the Emerald City: A guide to FIDIC's first tunnelling contract

This month's Talking Point helps you get to grips with the risk allocation in the first edition of FIDIC's tunnelling and underground works contract, as it differs significantly from other contracts in the FIDIC suite.

FIDIC published its Conditions of Contract for Underground Works in May 2019 in collaboration with the International Tunnelling and Underground Space Association (ITA-AITES). The contract is likely to be referred to as the Emerald Book because of its cover's colour (just as the other FIDIC contracts are).

Although the Emerald Book is based heavily on the FIDIC Yellow Book 2017 (the clause numbering is the same, for example), it is specifically designed to tackle the particular challenges of projects involving tunnelling and underground works. These arise because subsurface conditions are uncertain. The new contract addresses these by carefully apportioning risks between the Employer and Contractor. The hope is that this clearer and fairer balance will make contracting more predictable and so prove popular in the market and contribute to the growth of the sector.

A whirlwind history of underground contracting

The industry has struggled to find an international standard for underground works contracts. In fact, differing procurement methods, such as employer-design, early contractor involvement, design and build, or EPC, are used. The underlying contracts are based on NEC contracts, national standard forms, or the other FIDIC contracts, none of which are intended for underground works specifically. This way of reaching agreement has often failed to allocate risks properly and to attach importance to ground assessments, preparations for excavation and ground support works. This is because existing standard form contracts view such preparatory works as preconditions only or even neglect them entirely. Consequently, problems arising from disparities between the expected and actual geological, geotechnical and structural conditions underground have caused losses of time, resource, trust and reliability.

More balanced risk management – the technicolour light at the end of the tunnel?

Against this background, the Emerald Book is a welcome attempt to tackle these failings. It sets out a novel, but appropriate, way of managing the allocation of ground condition risk, describes how to create technical and detailed project schedules based on geotechnical baseline reports and establishes a mechanism for flexible yet structured adjustments to the schedules.

Parties therefore need to understand the premise for ground condition risk management in the contract if they are to use it successfully.

"We're not in Kansas anymore" – a new risk allocation philosophy

The drafters clearly believe there would be an inappropriate imbalance between the Employer and the Contractor if all risks arising out of unforeseeable circumstances, and especially unpredictable subsurface conditions, were assigned to the Contractor. Instead, the Emerald Book rests on the principle that parties should mutually define the subsurface conditions. This encourages early in-depth preparation and cooperation and provides a base for establishing common expectations on the project.

As a result, the risks arising from unforeseeable conditions are assigned separately from the risks derived from the expected subsurface conditions. The unforeseeable risks lie with the Employer as the party who can best control such risks and benefits most from the project. The expected risks are assigned to the Contractor, the party with experience and specialist knowledge in adjusting design and construction.

Two important aspects of how this risk allocation plays out are:

- Geotechnical Baseline Report and Baseline Schedule

The Emerald Book establishes how the expected ground conditions are defined. The Geotechnical Baseline Report comprehensively sets out the anticipated subsurface conditions on which the contractually agreed excavations, lining design and construction methodology can then be based (recorded in a Baseline Schedule). These documents are an integral part of the agreement and must reflect the distribution of obligations and risks between the parties. The Geotechnical Baseline Report and Baseline Schedule allow for more transparency because they capture the parties' common understanding before works begin and can be referred to throughout the project.

Clearly, operating this contract effectively requires the detailed and careful preparation of these documents well before the contract is signed. You therefore need to be ready to make significant resources available to prepare them thoroughly.

- Adjusting the Time for Completion and Contract Price

The Emerald Book contains a flexible mechanism for adjusting the agreed Time for Completion and the Contract Price. A provision unique to the Emerald Book in the FIDIC suite states that if the Contractor comes across unexpected ground conditions, the Contractor must measure and report the actual excavation and lining works it carries out so that the response can be compared to the Geotechnical Baseline Report and the Baseline Schedule. The resulting differences in necessary time and cost can then be used to determine any appropriate levels of adjustment.

Significantly, the allocated time and costs can be extended as well as reduced, depending on whether the unexpected ground conditions are better or worse than expected. This further supports the principle of balancing the risk allocation because the Employer will both bear the risk and reap the rewards of unforeseeable ground conditions.

Will FIDIC Emerald be garlanded with praise?

The Emerald Book is welcome in a sector that has often lacked sophisticated contracting.

Being a contract based on the FIDIC Yellow Book 2017, the ultimate reception of this contract will no doubt depend on whether the market is willing to take on the extra resources and training required to get parties who are comfortable with the FIDIC 1999 suite to adopt the processes of the 2017 suite in which there is much more emphasis on actively managing and avoiding claims and disputes.

Parties will also need to negotiate and manage other issues highlighted by the industry relating to the FIDIC Yellow Book 2017. These have meant that, so far, the 2017 suite has not been taken up enthusiastically by a significant section of the international construction industry.

However, it is still early days, and it may well be that the Emerald Book not only establishes itself as the go-to standard form for tunnelling but also acts as a catalyst for the uptake of the 2017 FIDIC Red, Yellow and Silver Books. FIDIC took the unusual step of publishing the Emerald Book without issuing a test edition. Perhaps FIDIC was keen to push out a contract that those doing underground works would be keen to try, given the lack of alternatives, knowing that parties would gradually become familiar with the 2017 approach at the same time, and be more amenable to switching to the newer suite on other projects.

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Conversation: Archaeo-Engineer

How studying ancient buildings can improve modern ones

John Ochsendorf, professor of architecture at MIT, studies ancient structures like Inca suspension bridges and Roman domes. Last year he was awarded a $500,000 MacArthur Fellowship in recognition of his unique achievements in both the fields of preservation and design. Ochsendorf spoke with ARCHAEOLOGY's Nicole Albertson about his first excavation, Inca construction sites, and what the ancients can teach today's engineers.

Do you consider yourself an archaeologist or an engineer?

I'm definitely an engineer. Archaeology is my love, but I don't have the degrees. I don't think there is an archaeology faculty that would want me. But for the last seven years I've built up a research group at MIT that studies historic structures. We look at everything, from the stability of Maya arches to the design of Roman aqueducts.

Why does ancient architecture intrigue you?

There are many lessons we can learn from studying these structures. A major concern today is how to build buildings that use fewer resources. Pre-industrial construction methods can teach us fundamental lessons about sustainable design and the environmental impact of our buildings today. For example, modern homes are cooled by inefficient air-conditioning units powered by electricity that is mostly generated by burning coal far away. Ancient homes around the world were cooled naturally through smart design. We won't go back to living in caves, but in the 21st century and beyond, we will need to be much smarter about how we use our natural resources for our buildings.

How does an engineer get so passionate about history and archaeology?

After two years of studying engineering, I went on a dig near Ithaca, New York. I spent a whole day digging test pits and found absolutely nothing. And it was just the greatest day of my life.

You were hooked?

I went back to my adviser in engineering and I said to her, "Thank you for your help, but I've decided I'm going to become an archaeology major." She said, "That is a fantastic idea. You should definitely do archaeology, but don't leave engineering." And she helped me design a major that combined archaeology and structural engineering.

Did you do more fieldwork?

I spent much of one summer doing fieldwork in the Andes as an undergraduate. I hiked the Inca road system, documented the remains of suspension bridge abutments, and visited the last known Inca suspension bridge in a remote region of Peru. The Inca city of Ollantaytambo particularly stood out to me because it was abandoned while being built about 500 years ago, and it's as if all the workers had just set down their tools. If we were to dream up a site to see how the Inca built their marvelous stone monuments, this would be it.

What do you look at first when you visit an ancient site?

I inspect the stones. I look for the marks of the people who made them, and examine how they shaped or finished the material. I have this idea that borders on the romantic--that there is a direct connection between me and a person who lived centuries or millennia before, and devoted weeks or years of their life to these stones.

What are you working on now?

I'm collaborating with archaeologist Sandra Lucore, who is excavating the North Baths at the ancient Greek city of Morgantina in Sicily. We want to know whether the geometry of the building was so stable that only something radical like an earthquake could have made it come down, or if it was an experimental design that was not very stable and may have collapsed under its own weight.

What is the biggest difference between being an engineer and an archaeologist?

It's easy with an engineering education to think of ancient people as primitive. But the truth is, in terms of the materials and construction, there is a tremendous amount of knowledge they had that we no longer possess, particularly masonry techniques. I really believe that we as engineers still have a lot to learn from studying these monuments and that we should be humble. We are learning from the masters.

I have to ask, what are you doing with the prize money from your MacArthur Award?

I'm worrying less!

Archaeological Institute of America, Archaeology, Volume 62 Number 3, May/June 2009,
https://archive.archaeology.org/0905/etc/conversation.html

ΔΙΑΚΡΙΣΕΙΣ ΕΛΛΗΝΩΝ ΓΕΩΤΕΧΝΙΚΩΝ ΜΗΧΑΝΙΚΩΝ

Young Members Group (ITAYM)

Meet the ITAYM Board

The governing structure of the International Tunnelling & Underground Space Association's (ITA) Young Members group (ITAYM) is a Steering Board made up of Chair, Vice-Chair, and a number of representatives selected by members of the Group. Steering Board members are elected for alternating periods to ensure continuity. The mandate is for two years.

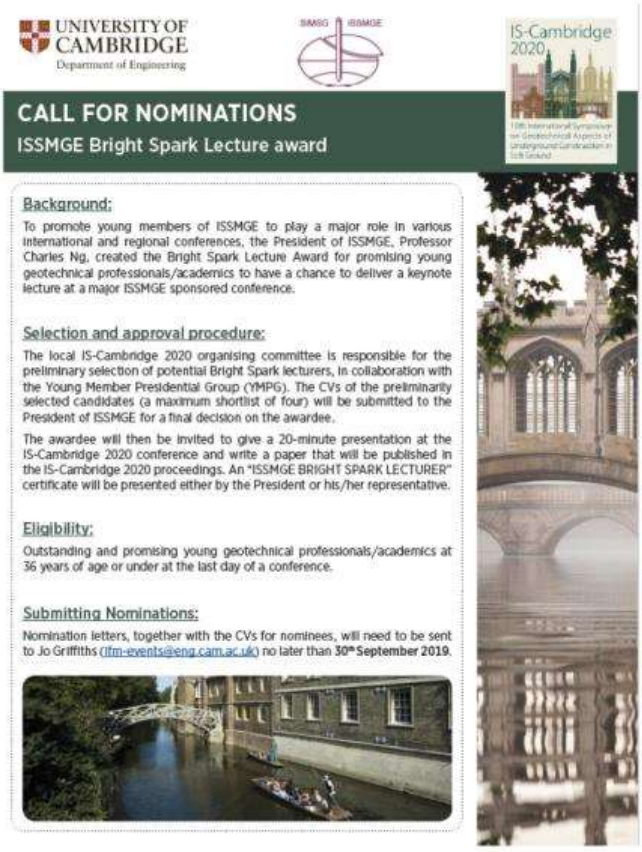
- Keith Bannerman
- Jasmin Amberg
- Giuseppe Gaspari
- Jekaterina Jonsson
- **Chrysothemis Paraskevopoulou**
- Nicolas Ziv

Chrysothemis is a Tunnel/Mining Engineer (MEng) with post-graduate studies (MSc) in Tunnelling from NTUA (GR). In 2016, she completed her PhD, which involved working on a joint Research Project between Queen's University and ETH Zurich. She is currently an EMBA candidate. In 2017 she was appointed Assistant Professor at the University of Leeds (UK). She also works as an Independent Consultant and in the past as Tunnel Engineer. She is an active member in the Greek and British Tunnelling Society Young Members groups and the ITA's ITACUS and ITACET committees. When Chrysothemis is not working, you will find her spending time with friends and family at her Eden, a magical place in Southern Greece.

(Breakthrough Issue 5, 2019, p. 5)

ΝΕΑ ΑΠΟ ΤΙΣ ΕΛΛΗΝΙΚΕΣ ΚΑΙ ΔΙΕΘΝΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΝΩΣΕΙΣ

INTERNATIONAL SOCIETY FOR SOIL MECHANICS AND GEOTECHNICAL ENGINEERING



Nomination letters, together with the CVs for nominees, will need to be sent to Jo Griffiths (lfm-events@eng.can.ac.uk) no later than **30th September 2019**.

INTERNATIONAL COMMISION ON LARGE DAMS

01/08/2019

CIRCULAR LETTER N°1954

To all National Committees

ACCESS TO RECENT ICOLD PUBLICATIONS

Dear President,

Recent publications (Bulletins and Congress Proceedings), starting in 2018, are published by our new publisher, Taylor and Francis (CRC Press, Balkema)

You will find these publications on the ICOLD website, with an additional "**external link**" indication, as well as the CRC logo. If you click on the link, you will be automatically redirected to the new editor's website.

ICOLD members benefit from a dedicated portal when they click on the "external link", reserved for members.

Once on this portal, click on **publications**, and enter the following information **to log in**:

Login: **ICOLD-Member**
Password: **2019*!COLD-Members**
Note: ! replace I in ICOLD

You will have access to **free publications**, as well as member-only **discounted rates**.

THIS MESSAGE IS TO BE DISTRIBUTED TO ALL YOUR MEMBERS.

If there is a problem, contact daniel.couvidat@icold-cigb.org

CENTRAL OFFICE

British Section

Professor Roger Frank awarded the Sir Alcon Copisarow Medal

On 1st July 2019, at the centenary dinner of the British section of the Société des Ingénieurs et Scientifiques de France (IESF) Professor Roger Frank, Immediate Past President of the ISSMGE was awarded the Sir Alcon Copisarow Medal. The Sir Alcon Copisarow Medal is for the promotion of International collaboration, the delivery of major projects or assignments, research and the dissemination of learning and educational opportunities, together with Scientific and Engineering achievement, for the benefit of future generations. It is awarded approximately every five years.

Lady Diana Copisarow presents the Sir Alcon Copisarow Medal to Professor Roger Frank

Lady Diana Copisarow presented the medal in honour of her husband, who was the Patron of the British section of the IESF for many years, at their Centenary Anniversary Gala Dinner held in the Great Hall of the Institution of Civil Engineers, London, UK.

The citation was given by Professor Lord Robert Mair, Patron of the IESF British Section:

"Professor Roger Frank is recognised for his outstanding contributions in the field of science and engineering, through original research, teaching, collaboration and scientific presentations all around the world. One of his most notable contributions is in leading in collaborative style the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE), comprising 89 Member Societies and around 21,000 individual members, which is recognised as providing the focal point for Member Societies in 90 countries.

Born in New York, raised in the UK, Switzerland and France (and married to his Greek wife Vassilia), Roger Frank speaks various languages which helps to facilitate the maintenance of his large international network of colleagues and friends.

Prof. Lord Robert Mair delivers his citation for Professor Roger Frank

Roger Frank studied for a degree in Civil Engineering at the École Nationale des Ponts et Chausées (ENPC) and for a Doctorate in Engineering at the Pierre et Marie Curie University, Paris (1974). He was awarded a Doctorate in Science at the same university in 1984.

He was first employed by the Laboratoire Central des Ponts et Chaussées' (LCPC), where he became Head of the Foundations Section and later the Head of the Soil Mechanics and Foundations Division in 1990. From 1992 to 2003, he was the Director of CERMES (ENPC-LCPC) and in 1997 was promoted to the rank of Professor in geotechnical engineering at ENPC. He is now Honorary Professor of Geotechnical Engineering and Emeritus Research Director at the ENPC.

In his career, Roger Frank has not only been active at ENPC but has made many contributions elsewhere. He has been a long-standing supporter and officer of ISSMGE serving as Vice-President for Europe (2005-2009), Appointed Board Member (2009-20013), President (2013-2017) and remains on the Board of ISSMGE as Immediate Past President. He chaired the Eurocode 7 committee on Geotechnical Design from 1998-2004 at a crucial stage in formalising the code. He has been a member of the Advisory Committee (Environment & Construction) for the University of Minho, Portugal and has served as an External Council Member for the National Technical University of Athens from 2013 – 2016). He was the first President of the European Civil Engineering Education and Training Association from 2009-2010. He has spent over 40 years teaching and researching in the fields of soil mechanics and geotechnical engineering. He has delivered invited lectures in 58 countries and been the author or co-author of more than 200 papers including 45 co-authored with foreign colleagues.

By his work on Eurocode 7, Roger Frank has promoted and facilitated standardisation in geotechnical engineering via agreements reached between experts from quite distinct technical cultures. Through training, conferences and presentations about Eurocode 7, he has had a direct influence in bringing about improvements in geotechnical practice in construction and civil engineering.

Roger Frank has promoted international collaboration. He collaborated for many years with the UK Building Research Establishment and with Imperial College with the aim of improving buildings and infrastructure. He has lectured

overseas in many cities and countries including Prague, Budapest, Zagreb, Slovenia, South Africa, and Spain and across Canada.

Roger Frank has received many honours and awards including the Chevalier de l'ordre national du Mérite, France (2000), Doctor Honoris Causa of the Technical University of Construction, Bucharest (2005), the UK Institution of Civil Engineers George Stephenson Medal (2008), the Széchy Károly Medal, Hungary (2011) and the Dr Beer Prize, Belgium (2013).

Professor Roger Frank has made a remarkable international contribution in the field of science and engineering, through original research, teaching, collaboration and presentations all around the world. He embodies the spirit of international collaboration and today is a world recognised ambassador for geotechnical engineering and human endeavour."

Roger Frank then gave his acceptance speech:

"My Lord, Lady Diana Copisarow, Monsieur l'Ambassadeur de France, Mr President of the British Section of IESF, Mr President of the British Geotechnical Association, Madame la Présidente du Comité Français de Mécanique des Sols, Madame la Directrice de la Recherche de l'Ecole nationale des Ponts et Chaussées, Dear Presidents, Directors, Colleagues and Friends, Chère Cocotte, Αγαπημένη Βασιλεία, Ladies and Gentlemen, Mesdames, Messieurs,

I feel most honoured to be awarded the prestigious Sir Alcon Copisarow Medal. The career of Sir Alcon Copisarow is an outstanding example of promotion of international collaboration, in particular scientific and engineering achievements for the benefit of future generations.

This award made me think more about my international activities and positions with regard to future generations, as the Chair of the Committee on Eurocode 7 for "Geotechnical Design" (from 1999 to 2004) or more recently as the President of the International Society for Soil Mechanics and Geotechnical Engineering (from 2013 to 2017).

Prof. Roger Frank delivers his acceptance speech

When thinking of future generations, we most often mention problems linked to climate change and other important environmental issues such as ensuring the biodiversity of species and spaces; we also mention the burden of financial debt; more rarely do we think of - or mention - the knowledge we leave to future generations (such as scientific and engineering knowledge) and the way we transmit this knowledge or, importantly, the way it gets lost.

I am grateful to the British Section of IESF, for recognising my small contribution to Sir Alcon Copisarow's ideals.

Roger Frank with Richard Coackley, President of the IESF British Section

The British Section of IESF is a beautiful example of Franco-British friendship. Allow me to confess to you that I am a pure result (if I may say so) of Franco-British friendship. My parents met here in London during the 2nd World War. My mother, who was British (she was born in London; her father was Hungarian and her mother was French) was in the British SOE and my father, who was of Russian origin, had joined the French army and escaped from occupied France to join the Général de Gaulle in London. Where else could they meet than in the UK, during those years of chaos, fascism and intolerance? We have two heroes in our family, whatever our political orientations: Sir Winston Churchill and the Général Charles de Gaulle.

The Franco-British friendship has survived and will undoubtedly survive all political vicissitudes on both sides of the Channel.

By the way, we are 4 brothers and sisters. My older brother, Richard and my older sister, Odile, present with us this evening, were born in London; my twin sister, Geneviève, married an Englishman. I am the only one who is not British and French at the same time; nobody is perfect!

Allow me another confidence: when I was about 5 years old, I would say 'I want to be an engineer, I want to be an engineer' with my wooden lorry banging down the stairs of our first family house at Stamford Hill, in the Borough of Hackney, London N.16.

I am grateful to my parents and siblings, represented here by my older sister Odile, to my family, to my wife Vassilia, present here with us, to my children Laura and Dimitri, not here today, my friends and colleagues all over the world, those who could come today, those who could not make it.

I am grateful to the 'Ponts et Chaussées' administration (French Bridges and Highways Administration). I can say that I immigrated to France because of and for the 'Ponts et Chaussées'. They made of me a citizen of France, a citizen of Europe and a citizen of the world. I am grateful to all for having created the conditions to help me develop a captivating international career leading to the ceremony of today.

Thank you for your patient attention!

Merci de votre attention et de votre patience !"

ΠΡΟΣΕΧΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΚΔΗΛΩΣΕΙΣ

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

The 17th European Conference on Soil Mechanics and Geotechnical Engineering, 1st - 6th September 2019, Reykjavik Iceland, www.ecsmge-2019.com

NORDIC GROUTING SYMPOSIUM 2019, September 2-3, 2019, Helsinki, Finland, https://www.ril.fi/en/events/nordic-grouting-symposium-2019.html

4ο Πανελλήνιο Συνέδριο Αντισεισμικής Μηχανικής & Τεχνικής Σεισμολογίας, Αθήνα, 5 – 7 Σεπτεμβρίου 2019, https://conv.eltam.org

SECED 2019 Conference Earthquake risk and engineering towards a resilient world, 9-10 September 2019, Greenwich, London, U.K., www.seced.org.uk/2019

15th International Benchmark Workshop on Numerical Analysis of Dams, 9th - 11th September 2019, Milano, Italy, www.eko.polimi.it/index.php/icold-bw2019

3rd International Conference "Challenges in Geotechnical Engineering" CGE-2019, 10-09-2019 - 13-09-2019, Zielona Gora, Poland, www.cgeconf.com

XVIII Technical Dam Control - International Conference Hydraulic Structures Monitoring and Safety, 10-13 September 2019, Warsaw, Poland, www.tkz.ibs.pw.edu.pl

International Symposium on SPH and other particle-based continuum methods and their applications in geomechanics, 11-13 September 2019, Vienna, Austria, https://sph-vienna.com

14th ISRM International Congress, 13-18 September 2019, Iguassu Falls, Brazil, www.isrm2019.com

ISGHS 2019 International Symposium on Geotechnical aspects of Heritage Structures, September 16-18, 2019, IIT Madras, Chennai, India, www.igschennai.in/ISGHS2019

12th Asian Regional Conference of IAEG, 21 ~ 27 September 2019, Jeju Island, Republic of Korea (South Korea), www.iaegarc12.org

1st MYGEC 1st Mediterranean Young Geotechnical Engineers Conference, Double Events – MYGEC & EYGEC, 23-24th September, 2019, Bodrum, Muğla, Turkey, http://mygec2019.org

International Conference on "Landslide and Slope Stability'
September 25 -29, Bali - Denpasar, Indonesia
www.slope2019.com

CONFERENCE THEMES

- Mechanism of Slope Failures in Soils and Rocks
- General Landslides Studies
- The importance of Geological Aspects on Landslide and Rockslides
- Behavior of Soil and Rock for Slope Stability Analysis
- Physical Modeling and Material Testing for Slope Stability Analysis
- Dynamic Behavior of Soils and Rock for Slope Stability Analysis
- Site Characterization for Slope Stability Study
- Insitu Testing and Monitoring for Identification and Study of Slope Movement
- Climate Change and Land Use Impact on Landslides
- Problems of Creeps Causing Slope Failures
- Case Histories of Natural and Man Made Slope Failures
- Earthquake and Liquefaction Induced Landslides
- Landslides in River, Coastal and Submarine Environments
- Stability of Dams and Landslides in Reservoirs
- Design Aspects for Slope Stability
- Slope Stability in Excavation and Embankment Works
- Use of Piles and Ground Anchor for Slope Stabilization
- Reinforced Earth Slopes Design, Analysis and Case Histories
- Ground Improvement for Slope Stabilization
- Outlook for New Technology in Slope Stabilization
- Analysis of Debris Flows and Mudflows
- Modeling of Slopes and Application and Development of Numerical Analysis
- Probabilistic Slope Stability
- The Use of Remote Sensing for Landslides Response, Monitoring and Mapping
- Landslides Inventory and Landslide Hazard Zonation
- Remedial Measures on Landslides and Risk Reduction Strategy
- Monitoring, Prediction and Warning of Landslides
- Risk Assessment and Control on Landslides and Urbanization
- Policy, Legislation and Guidelines on Landslides
- Capacity Development for Landslides Mitigation
- Education on Landslides

Contact us on:

Email: secretariat@slope2019.com

27th EYGEC 27th European Young Geotechnical Engineers Conference, Double Events – MYGEC & EYGEC, 26-27th September, 2019, Bodrum, Muğla, Turkey, http://eygec2019.org

3rd ICTITG International Conference on Information Technology in Geo-Engineering, Sep. 29-02 Oct., 2019, Guimarães, Portugal, www.3rd-icitg2019.civil.uminho.pt

11th ICOLD European Club Symposium, 2 - 4 October 2019, Chania Crete – Greece, www.eurcold2019.com

Energy Geotechnics:
Mechanics of the energy transition
October 3rd, 2019, Delft, Netherlands
www.aanmelder.nl/energygeotechnics

The symposium "Energy Geotechnics: Mechanics of the energy transition" will be held on October 3rd, 2019 in the Science Centre of Delft University of Technology. The energy transition is without doubt one of the most important challenges Dutch and international society faces in the coming decades. The initiative for the symposium has been taken in order to give science and practice an opportunity to exchange ideas and experiences on this topic. The focus is on the geotechnical and geomechanical aspects of renewable energy production, distribution and storage.

This symposium has been organised under the auspices of the ISSMGE Technical Committee TC308 and Kivi Geotechnics.

Technical Sessions

- Energy Geostructures
- Energy Storage
- Material Behaviour
- Offshore Energy Geotechnics
- Induced Seismicity
- Heat Extraction & Distribution
- Innovative Ideas and Concepts

Contact

Energy Geotechnics Symposium 2019 - Mechanics of the Energy Transition, Netherlands

Chairs of the symposium:

Jacco Haasnoot: haasnoot@cruxbv.nl
Siefko Slob siefko.slob@cohereconsult.com
David Smeulders D.M.J.Smeulders@tue.nl
Phil Vardon p.j.vardon@tudelft.nl

4ο Πανελλήνιο Συνέδριο Αντισεισμικής Μηχανικής και Τεχνικής Σεισμολογίας *20 Χρόνια Μετά...*, Αθήνα, 4-6 Οκτωβρίου, 2019, www.eltam.org

XVII African Regional Conference on Soil Mechanics and Geotechnical Engineering 07-10 October 2019, Cape Town, South Africa, www.arc2019.org

2019 AYGE 7th African Young Geotechnical Engineers Conference, 6 October 2019, Cape Town, South Africa, www.arc2019.org/ayge-landing

HYDRO 2019 Concept to closure: practical steps, 14-16 October 2019, Porto, Portugal, www.hydropower-dams.com/hydro-2019

XVI Asian Regional Conference on Soil Mechanics and Geotechnical Engineering, 14 - 18 October 2019, Taipei, China, www.16arc.org

Developing Resilient Cities of the Future through the Integration of Tunneling and Underground Space Use, 15-17 October 2019, Nigeria, events@tunnellingnigeria.org

11ème Édition des Journées Africaines de la Géotechnique, 21-24 Octobre 2019, Niamey, Niger, http://ctgaafrique.org/niamey-niger-ville-hote-de-11eme-edition-journees-africaines-de-geotechnique

4th Regional Symposium on Landslides in the Adriatic-Balkan Region – ReSyLAB 2019 - 9th Scientific and Expert Conference GEO-EXPO 2019 23rd to 25th of October 2019, Sarajevo, Bosnia and Herzegovina, www.geotehnika.ba/ReSyLAB_&_GEO-EXPO_2019.html

8ο Πανελλήνιο Συνέδριο Γεωτεχνικής Μηχανικής, 6 – 8 Νοεμβρίου 2019, Αθήνα, Ελλάς, www.8hcge2019.gr

2019 GEOMEAST International Congress & Exhibition, 10 - 14 November 2019, Cairo, Egypt, www.geomeast2019.org

The 8th International Symposium on Roller Compacted Concrete (RCC) Dams, Nov. 11th – 12th, 2019, Kunming, China, chincold-en@vip.126.com, http://www.chincold.org.cn

8th International Geotechnical Symposium, 13-15 November 2019, Istanbul, Turkey, www.geoteknik2019.org/en/

XVI Panamerican Conference on Soil Mechanics and Geotechnical Engineering, 18-22 November 2019, Cancun, Quintana Roo, Mexico, http://panamerican2019mexico.com/panamerican

International Symposium on Rock Mechanics and Engineering for Sustainable Energy, 24-24 November 2019, Hanoi, Vietnam, http://vietrocknet.org

GEOTEC HANOI 2019 The 4th International Conference on Geotechnics for Sustainable Infrastructure Development, November 28 – 29, 2019, Hanoi, Vietnam, https://geotechn.vn

www.gege2019.com

Following the last two successful GeGe conferences held in Hong Kong (HKSAR) and Zhejiang, in 2015 and 2017, respectively. We are pleased to invite you to attend the 3rd International conference on Geo-Energy & Geo-Environment Conference in November 2019. This conference will cover both Geo-energy and Geo-environment areas that are highly relevant and essential to maintaining the sustainability of the society. Worldwide academics, engineeers, scientists are most welcome to join, to contribute and share the latest developments and information.

CONFERENCE THEMES

Geo-Energy

- Energy geo-structures such as piles, walls and tunnels
- Carbon Dioxide geo-storages andsequestration
- Radioactive waste disposal
- Energy extraction application such as conventional and unconventional energy, and geothermal energy

Geo-Environment

- Reused and recycled materials for geotechnical works
- Bio-geotechnology such as the use of vegetation and bacteria
- Landfills engineering
- Tailings dam engineering
- Heavy metal contaminated soil/water

CONTACT US

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Hunan University, ChangSha China
Tel: (86) 18711170964
gege2019@hnu.edu.cn

YSRM2019 - The 5th ISRM Young Scholars' Symposium on Rock Mechanics and REIF2019 - International Symposium on Rock Engineering for Innovative Future - Future Initiative for Rock Mechanics and Rock Engineering - Collaboration between Young and Skilled Researchers/Engineers – 1-4 December 2019, Okinawa, Japan, www.ec-pro.co.jp/ysrm2019/index.html

ICGU 4th 2019 4th International Conference on Ground Improvement and Ground Control (ICGI2019): Infrastructure Development and Natural Hazards Mitigation, 1-3 December 2019, Luxor, Egypt, https://icgi2019-ets.org/page/p/Welcome-ICGI

ETS Conference and Exhibition 2019, 4-5 December 2019, Luxor – Egypt, https://icgi2019-ets.org/page/p/Welcome-ETS

ISOG 2019 First Indian Symposium on Offshore Geotechnics, December 5-6, 2019, IIT Bhubaneswar, Odisha, India, https://sites.google.com/iitbbs.ac.in/isog2019/home

15th International Conference on Geotechnical Engineering, and 9th Asian Young Geotechnical Engineers Conference, 05 ÷ 07-12-2019, Lahore, Pakistan, http://www.pges-pak.org

GeoSS International Conference on Case Histories & Soil Properties, 5-6 December 2019, Singapore, www.iccs2019.org

1st ITA-CET Meeting for European Tunnelling Professors and PhD Students, 5-6 December 2019, Torino, Italy, ita-cet.secretariat@developpement-durable.gouv.fr

ISSPDS-Edinburgh 2020 2nd International Symposium on Seismic Performance and Design of Slopes, January 18–22, 2020, Edinburgh, UK, www.isspds.eng.ed.ac.uk

International Conference
on Geotechnical Engineering – Iraq
19 - 20 February 2020, Baghdad, Iraq
http://issmfe.org/international-iraqi-geotechnical-conference

International Conference on Geotechnical Engineering – Iraq, 2020 (ICGE–2020) is going to be held on 19-20th February on Baghdad, Iraq. It is organized by the Iraqi Scientific Society of Soil Mechanics and Foundation Engineering (ISSSMFE) in collaboration with Department of Civil Engineering / University of Baghdad.

The conference aims to provide a scientific platform to present and discuss the latest research and studies in the fields of Geotechnical Engineering. This scientific event is a great chance for participants from both academics and industry to meet and exchange the updating development and experiences in these fields. This conference will be real opportunity to share new ideas and experiences face to face, establish business or research relations, and find global partners for future collaboration.

Themes of Conference

- Spil improvement
- Shallow and Deep Foundations
- Soil Mechanics and Dynamics
- Unsaturated Soils
- Soil-Structure Interaction

- Engineering Geology
- Geoenvironmental Engineering
- Applications of Sustainability in Geotechnical Engineering
- Applications of Remore Sensing in Geotechnical Engineering
- Transportation Geotechnicque

Contact us

Issmfe.conference@gmail.com
http://issmfe.org/international-iraqi-geotechnical-conference

Eighth International Conference and Exhibition on
Water Resources and Renewable Energy Development in Asia
10 - 12 March 2020, Kuala Lumpur, Malaysia
www.hydropower-dams.com/asia-2020

We are pleased to invite the world's water and renewable energy community to **ASIA 2020**, which will take place in the city of Kuala Lumpur, Malaysia, in the luxurious Shangri-La Hotel, from 10 to 12 March 2020.

The event will have support from ICOLD, MYCOLD, the International Energy Agency, ICID, the Malaysian Government, CHINCOLD, and others from the hydro industry. Post-conference tours are being organized in conjunction with MYCOLD (Malaysia National Committee on Large Dams) and the power utility Tenaga Nasional Berhad.

Mission of the Asia 2020 Conference and Exhibition

As with the previous conferences in this series, which took place in Bangkok, Danang, Kuching, Chiang Mai, Colombo, and Vientiane,the emphasis will be on helping to turn renewable energy and water resources development policies into practice.By bringing together a multidisciplinary group of international experts, to focus on issues of specific relevance to Asia, we aim to stimulatenew partnerships, and produce concrete outcomes from the sessions and workshops.Training workshops will precede the event, panel discussions will be included, networking opportunities will be possible during socialevents, and technical tours will follow the conference. The exhibition, running concurrently with the conference, will showcase innovationand best practice.

Conference Themes

The following themes will be covered in the sessions and panel discussions. The detailed programme will be finalised in late June.

- Review of plans and progress in South and East Asia
- Sarawak Corridor of Renewable Energy (Score) initiative: plans, progress and updates
- The value of integrated regional development
- Transboundary collaboration and cross-border schemes
- Benefit sharing
- Financial aspects including risk management and private sector involvement
- Legal, contractual and insurance issues
- Dam engineering, with emphasis on innovative design, construction, and safety
- Materials for dams
- Innovative spillway design
- Implications of climate change
- Hydrology and flood management
- Environmental and social aspects
- Large and small hydropower plants and pumped storage
- Synergy between renewable energies
- Sedimentation
- Cascade developments and reservoir operation
- Hazard and risk, including seismic and geological risks
- O&M and powerplant safety
- Site planning for safety and efficiency
- Remote sites and extreme climates
- Appropriate low-cost solutions for rural electrification
- Training and capacity building

Contact Details

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GeoAmericas2020 4th Pan American Conference on Geosynthetics, 26-29 April 2020, Rio de Janeiro, Brazil, www.geoamericas2020.com

WTC 2020 ITA-AITES World Tunnel Conference, 15-21 May 2020, Kuala Lumpur, Malaysia, www.wtc2020.my

14th Baltic Sea Geotechnical Conference 2020 Future Challenges for Geotechnical Engineering, 25 ÷ 27 May 2020, Helsinki, Finland, www.ril.fi/en/events/bsgc-2020.html

Nordic Geotechnical Meeting Urban Geotechnics, 25-27 May 2020, Helsinki, Finland, www.ril.fi/en/events/ngm-2020.html

First International Conference on Embankment Dams: Dam Breach Modeling and Risk Disposal
5 – 7 June 2020 in Beijing, China
http://iced-2020.host30.voosite.com

The ISSMGE Technical Committee 210 on Embankment Dams is pleased to announce the launch of an ISSMGE TC210 conference series: International Conference on Embankment Dams. We would like to invite you to join us at the inaugural event of the conference series, the First International Conference on Embankment Dams (ICED'2020): Dam Breach Modelling and Risk Disposal, to be held in June 2020 in Beijing, China.

The two-day conference will consist of plenary, parallel and poster sessions presenting both invited and submitted papers, in conjunction with Keynote and Theme Lectures presented by leading international experts. Several Bright Spark Lectures will be presented to encourage brilliant young scholars to engage in TC210 activities. Workshops on specific topics and round table discussions are also programmed. Pre-and/or post-conference technical visits will be arranged.

TC210 of ISSMGE aims to promote co-operation and exchange of information concerning research and developments in geotechnical issues of dam construction among TC members and ISSMGE member societies, develop guidelines and bulletins for the design, construction and safe operation of embankment dams, interact with industry and overlapping organizations working in areas related to TC210's specialist areas, and assist with technical programs of international and regional conferences organized by the ISSMGE.

Conference Themes

In light of the occurrence of many major embankment dam failure events in the past few years, the symposium will address the most recent research and practice developments in embankment dam safety and risk management, stimulating fruitful scientific and technical interactions among the fields of soil mechanics, engineering geology, hydrology, fluid mechanics, structural and infrastructural engineering, and social sciences. The conference themes will include, but not limited to, the following topics:

- Case histories of failure of embankment dams and landslide dams
- Dam failure process modelling
- Soil mechanics for embankment dams
- Risk assessment & management
- Detection, diagnosis and mitigation of dam distresses
- Early warning and emergency response
- Intelligent monitoring and management of embankment dams
- Regulations and technical standards for embankment dam safety management

Contact us

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EUROCK 2020 Hard Rock Excavation and Support, 13-19 June 2020, Trondheim, Norway, www.eurock2020.com

DFI Deep Mixing 2020, 15 to 17 June 2020, TBD, Gdansk, Poland, www.dfi.org/DM2020

XIII International Symposium on Landslides - Landslides and Sustainable Development, June 15th – 19th 2020, Cartagena, Colombia, www.scg.org.co/xiii-isl

GEE2020 International Conference on Geotechnical Engineering Education 2020, June 24-25, 2020, Athens, Greece, www.erasmus.gr/microsites/1168

E-UNSAT 2020 4th European Conference on Unsaturated Soils - Unsaturated Horizons, 24-06-2020 ÷ 26-06-2020, Lisbon, Portugal, https://eunsat2020.tecnico.ulisboa.pt

Geotechnical Aspects of Underground Construction in Soft Ground
29 June to 01 July 2020, Cambridge, United Kingdom

Organiser: University of Cambridge
Contact person: Dr Mohammed Elshafie
Address: Laing O'Rourke Centre, Department of Engineering, Cambridge University
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16th International Conference of the International Association for Computer Methods and Advances in Geomechanics – IACMAG
29-06-2020 ÷ 03-07-2020, Torino, Italy

The 16th International Conference of the International Association for Computer Methods and Advances in Geomechanics (15IACMAG) will be held in Turin, Italy, 29 June - 4 July 2020. The aim of the conference is to give an up-to-date picture of the broad research field of computational geomechanics. Contributions from experts around the world will cover a wide range of research topics in geomechanics.

Pre-conference courses will also be held in Milan and Grenoble.

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7th International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics
13 – 16 July 2020, Bengaluru, India
http://7icragee.org

This International Conference is in continuation of previous six such conferences in which five were organized by Missouri University of Science & Technology, Rolla, USA, and the latest one was organized in Delhi under the leadership of Prof. Shamsher Prakash. The 7th International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics (ICRAGEE) will be held at Indian Institute of Science, Bangalore during July 13-16, 2020. The conference shall have invited Plenary lectures, Keynote Lectures, State of the Art and Practice (SOAP) Lectures, Special Presentation Lectures (SPL) and contributed original research papers for discussion and publication in the proceedings. It will provide a platform to review the contributions and accomplishments in the field of soil dynamics in the last few years and draw an agenda for the future course of action keeping the national and global needs in the forefront.

CONFERENCE THEMES

1. Field and laboratory testing of soils for the estimation of dynamic soil properties
2. Latest findings on liquefaction of soils
3. Seismic slope stability and landslides
4. Seismic design of retaining walls, marine structures, and dams
5. Seismic design of shallow and deep foundations
6. Soil-structure interaction under dynamic loading
7. Engineering seismology, strong ground motions
8. Ground response analyses and local site effects
9. Seismic hazard analyses
10. Seismic hazard zonation: microzonation projects and procedures
11. Seismic risk assessment
12. Ground improvement techniques for reduction of seismic hazard
13. Role of building codes in reduction of seismic risk
14. Wave propagation, engineering vibrations
15. Vibration problems of high-speed railways
16. Vibration absorption / isolation applications
17. Performance of constructed facilities in extreme events/case histories of geotechnical earthquake engineering
18. Reconnaissance reports of recent damaging earthquakes
19. GIS and remote sensing applications for geo-hazards
20. Sensors and satellite technology for disaster management
21. Seismic risk management and economics
22. Community preparedness and pre-earthquake disaster management
23. Innovative geotechnical applications in earthquake disaster management
24. Earthquake engineering education
25. Review of seismic design codes
26. Artificial intelligence in Earthquake Geotech engg. (Special Theme)
27. Seismic Analysis and Design of Waste Containment Systems (Special Theme)
28. Catastrophe and Risk Modeling (Special Theme)

Special themes added upon request

29. Ground Improvement Techniques
30. Shallow and Deep Foundations
31. Laboratory and Field Testing
32. Slope Stability, Retaining Walls and Geosynthetics

Contact Us

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Email conf@7icragee.org

ICGE - Colombo - 2020

3rd International Conference on Geotechnical Engineering
10 - 11 August 2020
@ Cinnamon Grand, Colombo, Sri Lanka

http://icgecolombo.org/2020/index.php

The Sri Lankan Geotechnical Society (SLGS) is pleased to announce its 3rd International Conference on Geotechnical Engineering (ICGE – Colombo -2020) to be held on 10 and 11 August 2020 in Colombo. ICGE – Colombo brings together the world community of engineers and scientists in every branch of geotechnical engineering. The conference will serve as a forum for reviewing the current state of the art and discuss future directions and exciting developments.

Themes

- Site Investigation
- Earthquake Engineering
- Landslides & Slope Stability
- Transportation Geotechnics
- Offshore & Harbor Geotechnics
- Environmental Geotechnics
- Ground Subsidence
- Problematic Soils
- Ground Improvement
- Analytical & Numerical Modelling
- Foundations
- Tunnelling & Deep Excavations
- Geosynthetics
- Engineering Geology & Rock Engineering
- Instrumentation & Monitoring
- Energy Geotechnics

- Case Histories

Contact Us

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ISFOH 2020 4th International Symposium on Frontiers in Offshore Geotechnics, 16 – 19 August 2020, Austin, United States, www.isfog2020.org

2020 CHICAGO International Conference on Transportation Geotechnics, August 30 - September 2, 2020, Chicago, Illinois, USA, http://conferences.illinois.edu/ICTG2020

EUROGEO WARSAW 2020 7th European Geosynthetics Congress, 6-9 September 2020, Warsaw, Poland, www.eurogeo7.org

37th General Assembly
of the European Seismological Commission
6 to 11 September 2020, Corfu, Greece
www.esc-web.org

6th International Conference on Geotechnical and Geophysical Site Characterization "Toward synergy at site characterisation", 7 ÷ 11 September, Budapest, Hungary, www.isc6-budapest.com

ICEGT-2020 2nd International Conference on Energy Geotechnics, September 20-23, 2020, La Jolla, California, USA, https://icegt-2020.eng.ucsd.edu/home

21-25th September 2020, Lisbon, Portugal
https://dw2020.lnec.pt

The Organising Committee of the **Fourth International DAM WORLD Conference** has the pleasure of inviting you to take part of the fourth edition of the **DAM WORLD** conference.

DW2020 is the fourth international gathering of a prestigious series of conferences on Dam Engineering. This series of conferences started in 2012. The first event was held in Maceió, Brazil, following Lisbon, Portugal in 2015 and Foz do Iguaçu, Brazil, in 2018. Returning to Lisbon in 2020.

The National Laboratory for Civil Engineering (LNEC) will be hosting DW2020 and I would like to send a friendly invitation to the international dam engineering community. The Conference aims to be a forum for disseminating the latest scientific and technical developments and for discussing the current problems, challenges and solutions faced by this important engineering sector. The Conference, in addition to technical sessions, will comprise Keynote Lectures from a team of experts, Pre-Conference One-Day Courses of great interest to professional practice and Special Sessions dedicated to topics of delegates special interest. Site Visits of technical and cultural interest will be organised. DW2020 Organisation Team will make all efforts to promote a fruitful and enjoyable networking among delegates and make DW2020 an unforgettable experience.

Themes and Topics

The conference will address concerns and achievements in the WORLD of DAMS, covering the following Themes/Topics:

Main Themes

T1 Concrete and Masonry Dams
T2 Embankment Dams
T3 Appurtenant Works
T4 Tailings Dams
T5 Environmental Issues
T6 Finance and Economic Aspects
T7 Regulation

Topics

ST1 Roller Compacted Concrete Dams (RCC)
ST2 Concrete Face Rockfill Dams (CFRD)
ST3 Design and Modelling
ST4 Dam Foundation and Geology
ST5 Seismic Analysis
ST6 Stability of Dams and Slopes
ST7 Monitoring and Instrumentation
ST8 Dam Safety Evaluation
ST9 Operation and Maintenance
ST10 Construction and Rehabilitation
ST11 Deterioration
ST12 Risk Assessment
ST13 Emergency Action Plan (EAP)
ST14 Geomembranes
ST15 Dam Management Systems and New Technologies
ST16 Design Innovation and New Materials
ST17 Dam Failure
ST18 Water Management
ST19 Hydraulics

ST20 Hydrology
ST21 Joint/Interface Problems
ST22 Sedimentation in Reservoirs and Related Problems
ST23 Decommissioning of Dams
ST24 Hydropower Issues

Contacts

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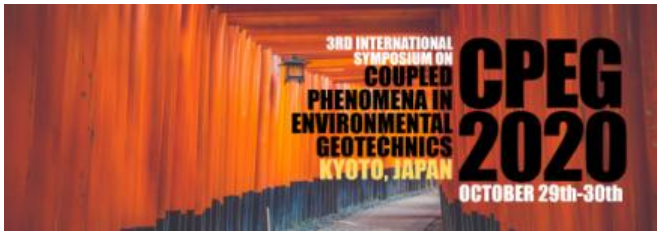

3rd International Symposium on Coupled Phenomena in Environmental Geotechnics
October 29th – 30th, 2020, Kyoto, Japan
https://cpeg2020.org

CPEG2020 is organized under the auspices of the Technical Committee TC215 (Environmental Geotechnics) of ISSMGE, and follows the very successful first two CPEG symposiums held in Torino (Italy) in 2013, and in Leeds (UK) in 2017.

CPEG2020 will be hosted in conjunction with the Japanese Geotechnical Society (JGS) and Kyoto University, and it will be followed by the 'Fifth World Landslide Forum' from November 2nd, making this a great opportunity to join both ISSMGE events in the Ancient Capital of Japan.

As we polish the details of the symposium, we will update the CPEG2020 website with further information, including keynote speakers, detailed symposium themes, and key dates. Please, keep the address of this site (www.cpeg2020.org) among your bookmarks for updated information.

5TH World Landslide Forum Implementation and Monitoring the USDR-ICL Sendai Partnerships 2015-2015, 2-6 November 2020, Kyoto, Japan, http://wlf5.iplhq.org

www.engr.psu.edu/xiao/ICSE-10 Call for abstract.pdf

Join Us for ICSE-10

Prospective authors are invited to submit abstracts for papers up to 300 words, which should include the title of the article, name(s) and affiliation(s) of the author(s), postal and electronic addresses, intended topic track, and at least three keywords. All submitted papers will go through a rigorous peer review process and only successful papers will be published in the conference proceedings.

The 3.5-day conference will include short courses, keynote and podium presentations, and a field trip.

To submit your abstract, please visit https://icse2020.submittable.com/submit

Topics

The conference invites you to submit abstracts that address scour and erosion related to the following topics:

- **Track A: Mechanics of Internal Erosion**. Including sub-topics such as mechanisms, field studies and observations, theoretical assessment of internal erosion mechanisms.
- **Track B: Sediment Transport: Grain Scale and Continuum Scale**. Including sub-topics such as advancement in sediment transport theories, tools, and new data sets for the understanding of sediment particle motion at both grain scale and continuum scale, and the implications for scour.
- **Track C: Effects of Geology on Internal Erosion**. Including subtopics such as anisotropy, heterogeneity, random field analysis, field investigations versus actual conditions.
- **Track D: Rock Scour**. Including sub-topics such as theoretical, computational, laboratory, and field studies on rock scour processes. Spillway and stilling basin erosion.
- **Track E: Erosion and Structures**. Including sub-topics such as bridge scour, internal erosion along structures, erosion around foundations, physical processes controlling the local scour around structures; interactions among fluid flow, sediment, and structures; new techniques and designs to alter the flow and scour processes.
- **Track F: River, Coastal, Estuarine and Marine Scour and Erosion**. Including sub-topics such as scour and erosion research and case studies specific for the riverine, coastal, estuarine and marine environments.
- **Track G: Numerical Modelling of Scour and Erosion**. Including sub-topics such as advanced computing techniques, numerical schemes, novel approaches for data assimilation, uncertainty quantification and analysis. Field and laboratory scale.
- **Track H: Physical Modelling of Scour and Erosion**. Including subtopics such as scale models, flume tests for internal and surficial erosion, centrifuge testing, small and large-scale testing.
- **Track I: Erosion Monitoring and Measurement**. Including subtopics such as novel sensors and instruments, subsurface monitoring, underwater monitoring, innovative

techniques, interpretation methods and data processing techniques for monitoring and measuring scour and erosion across spatial and temporal scales.

- **Track J: Watershed Scale Soil Erosion, Restoration, and Conservation**. Including sub-topics such as technology, management, and policy for the control of soil erosion at watershed scale including effect of land use change, riparian buffer construction to reduce sediment input, reservoir sedimentation and management.
- **Track K: Scour and Erosion Countermeasures and Mitigation**. Including sub-topics such as applications of both traditional and emerging countermeasures to scour and internal erosion problems.
- **Track L: Geo-Hazards Induced by Scour and Internal Erosion**. Including sub-topics such as debris flows, landslide, bank erosion, river meandering, and their impact to infrastructure.
- **Track M: Erosion Risk Assessment**. Including sub-topics such as assessment methods, risk assessment methods, mitigation methods, monitoring.
- **Track N: Case Histories, Lessons Learned, and General Practice**. Including practical aspects and lessons learned on technical topics in Tracks A through K such as success and failures related to innovative solutions, construction experience, field observations, etc.
- **Track O: Impact and Adaptation: flooding, drought, and scour in a changing climate**. Including sub-topics such as changing patterns of flooding and drought due to changing climate, potential effects of changing climate on scour prediction.

GeoAsia 2021

7th Asian Regional Conference on Geosynthetics
March 1-4, 2021, Taipei, Taiwan

EUROCK 2021
the ISRM European Rock Mechanics Symposium
1-6 June 2021, Torino, Italy

SYDNEY ICSMGE 2021
A GEOTECHNICAL DISCOVERY DOWN UNDER

20th International Conference on Soil Mechanics and Geotechnical Engineering
12-17 September 2021, Sydney, Australia
www.icsgme2021.org

Invitation

Dear Members of the ICSMGE,

On behalf of the Local Organizing Committee for the 20th International Conference on Soil Mechanics and Geotechnical Engineering (ICSMGE 2021), the Technical Committee and the host Australian Geomechanics Society (AGS), we are delighted to welcome you all to ICSMGE 2021, to be held in Sydney, Australia, from September 12 to 17, 2021.

The theme of ICSMGE 2021 is "A Geotechnical Discovery Downunder – Geotechnical Diversity Awaits You". Discover Australia and discover the innovation that lies where practical problems meet leading theoretical developments. ICSMGE 2021 will focus on the application of theory and the discovery that comes when world-class minds are focussed on the geotechnical problems facing our world. Our conference program and technical sessions reflect this emphasis on applications, and are designed to trigger collaboration, innovation and discovery from a diverse group of participants.

Australia is a unique land and a diverse country in every way imaginable – in culture, population, climate, geography and history. The identity of all Australians, but especially our Indigenous Australians, is shaped by our relationship with the natural environment. Sydney, as host city, has much to offer the tourist, with a diverse range of attractions. It is a multi-cultural city and its people are warm and friendly and very happy to greet you with a welcoming "G'Day!"

The Australian Geomechanics Society, the host society for ICSMGE 2021, truly embodies the diversity of our profession, welcoming geologists, engineering geologists, soil mechanics, rock mechanics and geotechnical engineers – practitioners and academics alike, who come together to help advance the profession in Australia and beyond.

ICSMGE 2021, Sydney, is an opportunity for delegates to make that once in a lifetime trip downunder and discover why there's nothing and nowhere quite like Australia.

We look forward to welcoming you, one and all, to our beautiful city of Sydney in September 2021.

Contact Us

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LATAM 2021
IX Latin American Rock Mechanics Symposium
20-22 September 2021, Asuncion, Paraguay

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3rd European Conference on Earthquake Engineering & Seismology, 19 – 24 June 2022, Bucharest, Romania, https://3ecees.ro

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

ΕΝΔΙΑΦΕΡΟΝΤΑ ΓΕΩΤΕΧΝΙΚΑ ΝΕΑ

Toddbrook Reservoir overflows after heavy rain

A dam wall at the 19th-century Toddbrook Reservoir has been damaged by days of heavy rain that has caused flooding across northern England.

Thursday 1 August 2019,
https://news.sky.com/video/toddbrook-reservoir-overflows-after-heavy-rain-11775086

https://www.nbcnews.com/video/evacuations-after-damage-to-toddbrook-reservoir-dam-near-whaley-bridge-england-65140805623

Toddbrook Reservoir is on the north-west edge of the Peak District National Park, sitting above the small town of Whaley Bridge.

Some experts say it was built in 1831, while the Environment Agency record it as being built between 1840-41.

The structure supplies water to the Peak Forest Canal, a waterway in northern England running between the town and Ashton-under-Lyne.

Owned by the Canal & River Trust, the reservoir is a Site of Special Scientific Interest (SSSI) due to local wildlife.

The spillway on the embankment dam, which releases water, became damaged following extensive rainfall on Thursday and partially collapsed.

Reservoir safety is maintained by inspections under an act created in 1930 and strengthened in 1975, according to experts, but flooding and other weather events have led to concerns about safety of older structures.

Professor Roderick Smith, from Imperial College London, said: "Extreme weather events mean that there is increasing unease about the safety of older dams: particularly the need to release excess water safely and easily."

The reservoir was damaged due to flooding in 1964, according to the Environment Agency, but another specialist said it was "unlikely" it had been in an unsafe condition before the heavy rainfall on Thursday.

Professor Tim Broyd, Professor of Built Environment Foresight at University College London, said: "Dams are highly regulated structures, which includes regular structural inspections by highly qualified engineers.

"It is unlikely therefore that the dam was in a previously unsafe condition.

"What may have been the cause, however, is that the flow rate into the reservoir was exceptionally high, as a result of extreme local rainflows."

Workers inspect the damaged dam after flooding

An RAF Chinook helicopter flies in sandbags to help repair the dam at Toddbrook reservoir near the village of Whaley Bridge in Derbyshire

https://www.standard.co.uk/news/uk/whaley-bridge-flooding-what-is-the-history-of-the-damaged-toddbrook-reservoir-a4203691.html

Workers on the scene have been pumping water out of the Toddbrook Reservoir after part of its spillway wall collapsed following heavy rains, jeopardising the lives of those who live in the shadow of the structure. Almost all of Whaley Bridge's 6,500 residents have now been evacuated as work continued through the night to manage the risk, but authorities say the threat of the dam failing remains.

"Due to heavy rainfall in Whaley Bridge area, the spillway is now broken and a big chunk of its concrete structure is damaged," said Dr Mohammad Heidarzadeh, Assistant Professor, Head of Coastal Engineering and Resilience LAB (CERLAB), Department of Civil & Environmental Engineering, Brunel University London. "There is a possibility that the spillway could then become fully broken in a few hours. If the spillway is fully gone, the embankment dam will be washed away very rapidly which could cause a massive flood."

To mitigate against this, Derbyshire police said the Chinook was used to drop more than 50 tonnes of aggregate material into the reservoir wall to reinforce it. Today the helicopter will drop more material in other parts of the reservoir in an attempt to stem the inward flow of water, reducing the overall level and the pressure on the damaged wall.

A total of 16 high pressure water pumps – provided by the Canal & River Trust and fire services across the country – have also been deployed in an effort to drop the reservoir's water level. Engineers from the Canal & River Trust, which manages the reservoir, are now assessing the damage and working with emergency services to ensure the safety of the local community.

"We don't know how long this operation will take to conclude but we and our colleagues in the emergency services, partner agencies, Environment Agency and military are doing everything humanly possible to save the reservoir wall and to protect the town," said Derbyshire Constabulary's Assistant Chief Constable, Kem Mehmet. "Our message today remains the same – as there is still a risk the dam will fail – please stay away from the area.

Commenting on the situation in Derbyshire, Tim Broyd, Professor of Built Environment Foresight, University College London said: **"**Whilst the dam appears to be safe at the moment, there would be risks that further heavy rain might lead to further scour, or that the force of water behind the dam will become higher than the gravitational resistance force of the weakened structure, and that further parts of the dam might collapse leading to a dam breach. If that happened, then the water impounded by the dam could very quickly flush out, with a very high flowrate and speed."

https://www.theengineer.co.uk/chinook-whaley-bridge/

Toddbrook Reservoir opened in 1838 as a feeder for the Peak Forest Canal. It is sited above the town of Whaley Bridge in the Derbyshire High Peak area. The reservoir is a Site of Special Scientific Interest (SSSI). It provides habitat for herons, ducks and other animals and fish. Also rare mosses and liverworts grow on its shores, particularly short-lived species that grow on seasonally exposed mud. The reservoir is also used for sailing and angling. It hosts many sailing events including DYS (Derbyshire Youth Sailing). The reservoir is owned by the Canal & River Trust and, like Combs Reservoir, is a feeder reservoir for Peak Forest Canal. The feeder runs though Whaley Bridge, and (along with the Combs feed) enters the canal system in a pool close to the transhipments shed at the Whaley Bridge Canal Basin.

The reservoir is fed from a stream named Todd Brook, which has a catchment area of around 1,700 ha including the Shining Tor moorland and the Kettleshulme village. Water enters the reservoir on its north bank through a small waterfall. The first several inches of this do not flow into the reservoir and continue flowing down the reservoir's run off and into the River Goyt. This means that the reservoir often receives little or no inflow during periods where rainfall does not allow the level to exceed this barrier. This often has significant impact on the reservoir's water level, particularly in the summer months.

The reservoir's dam is built largely from earth with a core of puddle clay.

Dam works

High rainfall levels resulted in damage to the dam's spillway in December 1964. The damage was repaired in 1965, but flood studies judged the spillway to be inadequate. As a result in 1971 a new concrete spillway was added to the centre of the dam.

In the 1980s, British Waterways carried out significant repair works to the dam to deal with leaks involving the mining shafts located around the dam. This resulted in a culvert being constructed under the current beach/launching area for the reservoir. A stone marker could be seen on the main beach showing the location of this for many years, but was relocated to the footpath opposite Toddbrook Lodge during access work for the 2009 draining.

It was known that the local coal mining industry had been a challenge for the dam's integrity for many years. The original builders were forced to purchase a block of coal below the dam in situ in order to ensure its mining did not cause structural issues.

The reservoir was also partially drained in 2009 for realignment works on the dam, and again in 2010.

2019 evacuation

On 1 August 2019, 1,500 residents of Whaley Bridge, Furness Vale and New Mills were evacuated after concrete slabs on the dam spillway partially collapsed. The Environment Agency issued a 'danger to life warning' in the area.

Wikipedia
https://en.wikipedia.org/wiki/Toddbrook_Reservoir

Deep dilemma for engineers designing giant metro cavern under North Sydney

Carved out of sandstone about 30 metres below North Sydney's streets, the giant underground cavern for a new train station will be one of the deepest on Sydney's new metro rail line.

Yet Victoria Cross station could have ended up much deeper – up to 60 metres below the heart of North Sydney, under engineers' early concept designs.

It would have allowed it to join the ranks of some of the deepest underground stations in the world, but would have meant that lifts were the only option to move thousands of commuters every hour between its 168-metre long platforms and the busy streets above.

"You start to get to a point where escalators are no longer working. We were determined not to get to that point because it starts to feel more inconvenient and it's harder to deal with larger volumes," Transport for NSW secretary Rodd Staples said on Monday.

NSW Premier Gladys Berejiklian and state transport minister Andrew Constance speaking to media in the tunnels of the North West Metro project in North Sydney about the breakthrough at what will become Victoria Cross station.

"We had to position the station so we could get people to the surface as quickly as possible. It's all to do with the harbour and the height of North Sydney."

The scale of the second stage of the $20 billion metro rail project was on show again on Monday as Premier Gladys Berejklian joined workers to watch the first of two tunnel boring machines break into the cavern at North Sydney, after worming its way from Crows Nest.

Premier Gladys Berejiklian joins workers to watch a giant boring machine break through at North Sydney on Monday.

"When you're above ground here in North Sydney you have no idea what's going on down here," she said.

The high elevation of North Sydney relative to Sydney Harbour presented major challenges for engineers designing Victoria Cross station and the route of the rail line.

They had to ensure the gradient of the track from a tunnel under the harbour to North Sydney – a distance of about 1.5 kilometres – was not too steep for the metro trains to climb, while making sure Victoria Cross station was not too deep below the surface.

One of the early options was for the route of the rail tunnel under the harbour to be closer to the western side of the Harbour Bridge. But that would have required the station to be dug deeper so the driverless trains could have climbed the gradient over a shorter distance.

Workers walk through a tunnel to the station's giant cavern about 30 metres below the surface.

In the end, engineers opted for a tunnel under the harbour between Barangaroo and McMahons Point, allowing Victoria Cross station to be dug to a shallower depth.

"A lot of the thinking about where to cross the harbour was all about how do we make Victoria Cross work. The concern was that the station would be too deep," said Mr Staples, the former project director for Sydney Metro.

"In the end we made it work better for [a station at] Barangaroo, as well as Victoria Cross."

The gradient of the line for metro trains can be no greater than 1.5 degrees, which is a steeper gradient than the city's double-deck trains can climb.

The station's underground cavern is about 260 metres long.

The underground cavern for the platforms is about 260 metres long and about 18 metres high, making it the largest on the metro line.

The platforms and tracks for north- and southbound trains will sit in the same cavern, unlike the stations at Martin Place and Pitt Street in central Sydney where basements of buildings meant they had to be separated.

With five giant boring machines churning away, about two-thirds of the twin 15.5 kilometre rail tunnels between Chatswood and Sydenham have now been dug.

And while Victoria Cross station is due to be completed by late 2022, trains will not run along the second stage of the line from Chatswood to the CBD and onto Sydenham and Bankstown until 2024.

Once open, the estimated journey time for the single-deck metro trains from North Sydney to Martin Place will be five minutes, and nine minutes to Central Station.

Patronage for Victoria Cross is forecast to reach 42,100 passengers a day by 2026, and 45,500 by 2036.

(Matt O'Sullivan / Transport Reporter for The Sydney Morning Herald, August 26, 2019, https://www.smh.com.au/national/nsw/deep-dilemma-for-engineers-designing-giant-metro-cavern-under-north-sydney-20190826-p52ks1.html)

Αστοχία Τοίχου Αντιστήριξης

https://www.facebook.com/watch/?v=396517997638056

(από τον συνάδελφο Νίκο Νάσκο)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΣΕΙΣΜΟΙ

Ridgecrest earthquake mystery: Why so little destruction from huge temblors?

Kristina Stockmyer and her husband Mark walk back to their home in the Heritage Village community of Ridgecrest, Calif., where most of the structures stayed intact after a pair of earthquakes hit the area last week.

After major temblors on July 4 and 5, structural engineers descended on Ridgecrest expecting to study destruction from the largest earthquake to hit Southern California in nearly 20 years.

They found relatively little.

Yes, mobile homes were torn off foundations, chimneys fell, gas lines leaked and some homes caught fire. But overall, most buildings did fine — and many businesses were up and running within a day or two of the biggest shock, a magnitude 7.1.

"Ridgecrest, I'm just amazed," California Earthquake Authority structural engineer Janiele Maffei said of the light damage.

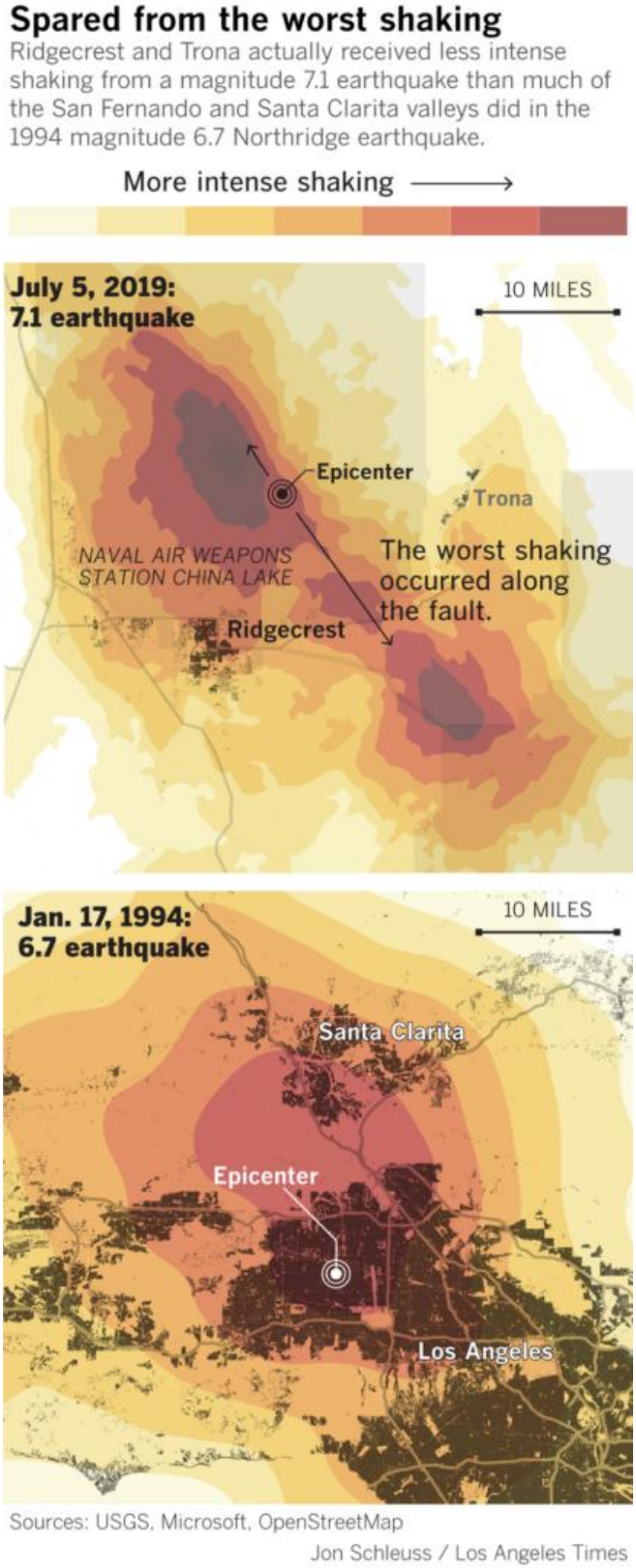
But the outcome in Ridgecrest shouldn't provide solace to California's biggest cities.

The Mojave Desert town remained largely unscathed because its building stock was relatively new and remarkably resilient. Many homes are one or two stories, built in the 1980s. It lacks the kind of structures that experts say are most vulnerable in a big quake — unreinforced masonry, brittle concrete, so-called soft story apartments and single-family homes not bolted to their foundations.

As a result, Ridgecrest suffered far less damage than cities hit by less powerful quakes in recent years, including Napa and Paso Robles, where older buildings in the downtown areas crumbled amid the shaking.

Experts were quick to point out that last week's quakes would have proved far more devastating had they been located near bigger cities filled with more susceptible buildings.

"You take a 7.1 and put it into the Hollywood fault or Newport-Inglewood fault in Long Beach — we're going to see substantially different levels of damage," said Ken O'Dell, president of the Structural Engineers Assn. of Southern California. "Ridgecrest did a very good job surviving this particular 7.1."



Keith Porter, a nationally renowned earthquake engineer and research professor at the University of Colorado Boulder, said Ridgecrest's result should not be seen as a "victory lap."

"We still have dangerous buildings, and we still have a building code that is not optimal and doesn't protect society

as well as it could," he said. "Instead of a dozen collapsed manufactured homes, hundreds or thousands of collapsed manufactured homes. Instead of four or so building fires, hundreds of building fires."

Progress has been made by cities — Los Angeles and San Francisco among them — to require some building retrofits. But even those large population centers have not mandated retrofits of all the types of structures engineers worry about. And authorities in many suburban areas — including in Silicon Valley, San Mateo County and the beach cities of L.A. County's South Bay — haven't ordered flimsy apartment buildings to be strengthened.

Many cities in Riverside and San Bernardino counties haven't required fixes to brick buildings, a vulnerability Californians have known about for a century.

A U.S. Geological Survey simulation said a plausible magnitude 7.1 earthquake on the Hayward fault in the Bay Area could kill 800 people, burn the equivalent of 52,000 single-family homes and displace 400,000 people, worsening the region's housing crisis.

And a hypothetical magnitude 7.8 earthquake that would send violent shaking waves along a 186-mile section of the southern San Andreas fault could kill 1,800 people, leave 50,000 injured and cause lasting harm to Southern California's economy.

Such a direct hit "would take days or weeks to get to the place we are [at in Ridgecrest] — gearing up toward restoration and early recovery," said Laurie Johnson, president of the Earthquake Engineering Research Institute.

Why Ridgecrest was spared

There are a number of reasons why Ridgecrest was largely spared.

The town, which began growing up the near Naval Air Weapons Station China Lake during World War II, does not have a stock of unretrofitted brick buildings like those constructed before the 1933 Long Beach earthquake, said USGS seismologist Susan Hough. Unretrofitted brick buildings are a major killer in quakes, causing at least five deaths in San Francisco during the 1989 magnitude 6.9 Loma Prieta earthquake and two fatalities in the 2003 magnitude 6.5 Paso Robles earthquake.

There are also very few "soft story" apartments with weak ground floors built to accommodate parking — likely, Hough said, a result of "having enough room to not ever need high-density housing." A soft-story apartment collapse killed 16 people in the 6.7 Northridge earthquake in 1994.

And because they are newer, the single-family homes in Ridgecrest lacked the vulnerability of many Southern California and Bay Area pre-1980 wood-frame houses built with a handful of steps above the ground. Sharp shaking can snap the wood supports connecting such homes to their foundations. A retrofit to brace and bolt the structure can cost several thousands of dollars — but repairing the problem after a quake can cost hundreds of thousands of dollars.

Repeating the July 4 and 5 quakes in the Bay Area and Southern California would result "in a lot of homes off their foundations," Maffei said. "Without retrofits, the Bay Area and Los Angeles do not have resilient housing."

There are at least 1 million of these vulnerable homes in California, but Ridgecrest has very few.

The more obvious signs of damage in Ridgecrest did not make many structures uninhabitable — cracked concrete walls surrounding yards or a broken decorative brick façade on a home, said Southern California structural engineer Wayne Chang, who visited the region Sunday and shared his observations with the Earthquake Engineering Research Institute.

Joaquin Vasquez, 12, looks over earthquake damaged shelves as his father, Alex Vasquez, cleans up their garage in Ridgecrest. "We lucked out. We didn't get much damage," Alex said.

Some of the worst damage was to mobile homes, which often are not secured to their foundations, engineers said.

The happenstances of geology and geography also worked in the town's favor.

The magnitude 7.1 earthquake started at an epicenter 10 miles northeast of central Ridgecrest. But it occurred on a fault that focused the worst shaking waves away from Ridgecrest and Trona, to the northwest and southeast, respectively, of the epicenter, and into sparsely populated areas, Caltech seismologist Egill Hauksson said.

On the Modified Mercalli Intensity Scale, Ridgecrest endured "very strong," or level 7 shaking, enough to break chimneys and damage badly designed structures but keep damage negligible in well-designed buildings. Trona got a level 6 "strong" shaking.

By contrast, much of the San Fernando and Santa Clarita valleys saw at least level 8, or "severe," shaking during the Northridge quake — an intensity that can greatly damage poorly built structures. (The shaking nearly caused a new steel frame Auto Club building in Santa Clarita to collapse and seriously damaged or destroyed 200 apartment buildings.)

Even though the Northridge earthquake produced much less total energy than the temblor on July 5, its location caused shaking to be worse directly underneath a highly populated area.

Trona, an older city, was more heavily hit than Ridgecrest.

Although the shaking was less intense, Trona's location on soft sediments that have eroded off a mountainside — known as an alluvial fan — caused the ground to act like quicksand, O'Dell said.

"That spreading of the soil undermined the foundations," he said, causing the base of buildings to come apart.

Chang said Trona's well-maintained homes seemed to withstand the shaking well, but some abandoned and unoccupied houses suffered collapsed walls.

There are few public details so far about the structural damage suffered at the Naval Air Weapons Station, which has been directly on top of recent earthquakes. Conditions have forced personnel to evacuate.

So far, authorities believe one person has died as a result of one of last week's earthquakes — a Nevada man found

pinned under his Jeep after the vehicle fell off its jacks.

What should be done

Engineers and safety advocates say more can be done before the next big quake hits California. That includes bolting bookshelves to walls, arming kitchen cabinets and clothing dressers with toddler-safe locks, and using quake putty to affix breakable items to shelves.

Porter wants lawmakers to look to strengthen the state's minimum building requirements, which he says currently allow for construction just strong enough to not collapse in a quake.

"People think a new building is earthquake-proof. But really, all it's supposed to do is not collapse and kill you," Porter said. "The damage can be so costly that you can't afford to fix it; that it doesn't make sense to fix it."

He urged lawmakers to reconsider a measure vetoed by then-Gov. Jerry Brown in 2018, which called for a tougher construction code to keep new buildings usable after a major earthquake.

Porter also said cities need to tackle the vulnerabilities presented by some of California's largest buildings.

Los Angeles, for instance, has yet to decide how it wants to address the risk of steel moment frame buildings constructed before the Northridge quake; the USGS has said it is plausible that five high-rise steel buildings in Southern California could topple in a magnitude 7.8 quake.

San Francisco has yet to decide on how it wants to deal with its stock of about 3,000 potentially vulnerable brittle concrete buildings, the kind that collapsed in the Northridge and Sylmar earthquakes.

"If we think it's expensive to fix those buildings, wait until we get the bill for not fixing them," Porter said. If a financial district is obliterated by the collapse of a single steel skyscraper, Porter said, "who is going to want to go into all the other ones that didn't collapse? Our trust in those buildings will evaporate."

It's time to move beyond simply preparing an earthquake kit as the main way to prepare for the Big One, O'Dell said.

"Being prepared is more than having your kit stocked, it's more than having a hard hat under your bed," O'Dell said. "We need to be preparing our buildings."

(Rong-Gong Lin II Staff Writer / LOS ANGELES TIMES, July 10, 2019, https://www.latimes.com/local/lanow/la-me-ln-earthquake-ridgecrest-worse-20190710-story.html)

How Ridgecrest earthquakes helped scientists with ShakeAlert

Meet USGS Geophysicist Sarah Minson

US Geological Survey geophysicist Sarah Minson was in the thick of efforts to develop an earthquake warning system in California when a series of major temblors struck the sparsely populated community of Ridgecrest in the Mojave Desert this summer. The largest, a magnitude 7.1 quake on July 5, was the biggest to hit the state in decades.

We asked her about her work — and how this month's big quakes is helping scientists refine California's fledgling earthquake alert system.

Q Tell us about your role with helping to develop the ShakeAlert system.

A At the moment one of my projects is to ask questions about what the best possible earthquake early warning system could do based on how fast seismic waves travel so that we can measure ourselves against what the perfect ideal would be. It's important to know what's the best you can possibly do to know how close you are to getting there.

Q Are there good systems already out there?

A We're not the only early warning system. Japan has been running an earthquake early warning system for many years now. Of course, all these different countries have all these different seismic hazards. The question is, what are they doing and would that apply in the U.S.?

Q What did you learn from Japan?

A In Japan, they alert for a much higher level of shaking than had even been discussed for California because of the difference in how frequently they happen there. When we were talking to them about what level shaking we think we should be warning about, in Japan that is a ridiculously low threshold. Alarms would be going off all the time.

Q What was significant to you about the Ridgecrest earthquake?

A The chance to interact with people. This was the first earthquake that has been significant, that people noticed, since the earthquake early warning system started. This is our chance to actually get feedback. Is this what people wanted?

Q The ShakeAlertLA mobile phone application did not activate in the Los Angeles area because the quake was in the neighboring county and the shaking in LA didn't reach the intensity threshold to trigger an alert. How did people respond to that?

A The system worked, it picked up the earthquake, it picked up the shaking. The City of Los Angeles distributed the early warning app, and the system correctly identified that there would not be damage in LA. The app didn't put out an alert because there was no damaging shaking. But there were people who were unhappy, saying "I would have liked a warning" even though there was no damaging shaking. Different people may have different preferences. There's no right or wrong answer here. But just as with hurricane forecasting there's some uncertainty, where will it make landfall, how strong will it be? I do hope we can find a way to communicate any kind of forecast range of possible outcomes.

Q Will that lead to changes?

A The thinking was that the thing people would enjoy best is being warned before damaging shaking. Do people want alerts for any shaking they might feel including shaking they don't end up feeling, or for other types of shaking? Those conversations are already happening now and there may be an announcement of changes.

Q Where are we at in rolling out the ShakeAlert system statewide?

A We have a finalized plan. The plan is to go public California-wide sometime this fall.

Q What are the challenges?

A There are two limitations that are very important to understand. There's always going to be a region that is not warnable and that's from right where the earthquake begins to the nearest seismometer. The farther seismic waves travel is time you're losing to get a warning out. The target I believe is a minimum of one seismometer every 20 kilometers, with 10 kilometer spacing in densely populated areas, and within 5 kilometers of all mapped fault traces. We have been working for some number of years now to put sensors in the ground, but that requires getting permits approved.

This is a shaking forecast. Just like when you see a thunderstorm that looks like it might issue tornadoes or a hurricane and track it, there's a range on it because you're attempting to forecast the future based on information we have now. But what's interesting with earthquake warnings is that because the time involved is so short, the system has to be entirely automated. There's always going to be inherent risk that something incredibly stupid might happen that no human would allow.

Q Ridgecrest was hit by a significant magnitude 6.4 earthquake July 4 that's now being called a fore-shock to the much stronger 7.1 magnitude quake a day later. How unusual is that?

A It looks a lot like the Elmore Ranch and Superstition Hills earthquakes in 1987. (On. Nov. 24 1987, two significant earthquakes struck along the southern San Jacinto fault near the Mexican border in Southern California, the magnitude 6.2 Elmore Ranch earthquake and the magnitude 6.6 Superstition Hills earthquake a few hours later.) It's always fun when history repeats itself. In general, the rule of thumb is that if you experience an earthquake, the chance of another earthquake in the same week of larger magnitude is about 5 percent on average, or 1 in 20.

Q These earthquakes struck pretty far inland, we normally think of earthquakes along the San Andreas fault line. Are these related to the San Andreas?

A It's not part of the San Andreas fault but part of the same tectonic plate boundary. There's a much broader boundary zone in southern California, and these faults are part of that very broad zone. There are faults all across the state. In Northern California, there's the San Andreas, Hayward, Calaveras, a much narrower zone. In Southern California it's almost a sort of continuous transition from big faults along the coast all the way to faults in Nevada.

Q Do these big quakes affect the probability of earthquakes along the San Andreas?

A They're so far away from the San Andreas fault we don't think it affects the probability of anything happening on the

San Andreas.

Q Even though the damage was relatively light, it still has folks in Ridgecrest rattled.

A One thing that's interesting is how scary they are, how impactful and stressful earthquakes can be. Earthquakes can cause PTSD-like symptoms, and the continued shaking from aftershocks can be traumatizing even if they aren't damaging.

(John Woolfolk | jwoolfolk@bayareanewsgroup.com | Bay Area News Group / MERCURY NEWS, July 18, https://www.mercurynews.com/2019/07/18/qa-how-ridgecrest-earthquakes-helped-scientists-with-shakealert/)

Groundbreaking earthquake catalog may have just solved a seismic mystery

A crack in Highway 178 appeared after a 6.4 magnitude earthquake hit Ridgecrest, California, on July 4, 2019. A highly detailed catalog of quakes in Souhern California is helping geologists solve a long-standing mystery about the sequence of events that precedes an earthquake.

Lab-made quakes suggested that we should see hints of activity before a big event, but this pattern has been elusive in nature—until now.

For decades, scientists have searched for clues that would signal an impending earthquake. Teams have analyzed electromagnetic activity, weather patterns, and more only to scratch them off the list as potential harbingers of rocky destruction.

The only possible precursors that stood out were foreshocks, the tiny temblors that can occur before a larger main event. In lab experiments, foreshocks have been observed leading up to almost all simulated earthquakes. But this pattern has been missing in real earthquake data, vexing seismologists.

Now, though, a high-resolution catalog of millions of earthquakes in Southern California may have cracked the mystery.

In a recent study in *Geophysical Research Letters*, scientists examined a massive dataset of the region's big and small rumbles, and they report a distinct increase in seismic activity in the weeks and days leading up to the majority of earthquakes. The findings not only reconcile laboratory studies with real-world quakes, they also build confidence in the idea that foreshocks could one day be used as early warning signs, inching us closer to improving earthquake forecasts down the road.

"It's very much a first step and big leap forward in improving our understanding of earthquake processes," says Wendy Bohon, a geologist at the Incorporated Research Institutions for Seismology who was not a part of the study.

Foreshadowing shocks

Most earthquakes occur along faults, or deep cracks in the crust, where blocks of Earth slide against each other and create friction. This process builds stress and strain in the crust until the tension releases suddenly as seismic energy, producing an earthquake. Bohon compares an earthquake to breaking a pencil: You can see the pencil bend a little bit as you apply more pressure, but at some point, enough tension builds up so that the pencil snaps.

Almost 75 percent of earthquakes occur along tectonic plate boundaries, which cover thousands of miles of Earth's surface. We know earthquakes are constantly rattling our planet, so much so that geologists can confidently say that there is a 100-percent chance that an earthquake will strike somewhere in the world each day. In Southern California alone, the data show that an earthquake occurs almost every three minutes, on average.

It's much harder to narrow down exactly where and when one might strike. That's in part because earthquakes are difficult to directly observe, since they are triggered miles below the surface of Earth. As such, scientists often use lab experiments to simulate quakes and unravel their secrets.

Data from such experiments suggest that main quakes should be preceded by foreshocks, with tiny failures splintering across a fault when it approaches a critically stressed state.

But "real earthquakes are a much more complex system than our simple laboratory experiments," says lead author Daniel Trugman, a seismologist at Los Alamos National Laboratory.

What's more, foreshocks are expected to be relatively weak, and separating background noise from these types of rocky rumbles has long posed a major obstacle. Devices designed to "hear" earthquakes, called seismometers, also pick up a cacophony of surface activity, from hurricanes to car traffic to migrating elk, making it difficult to isolate such tiny quakes.

"Up until now, it has sort of been debated if all main shocks have foreshocks," says David "Chas" Bolton, a Ph.D. candidate in geosciences at Pennsylvania State University who was not a part of the study.

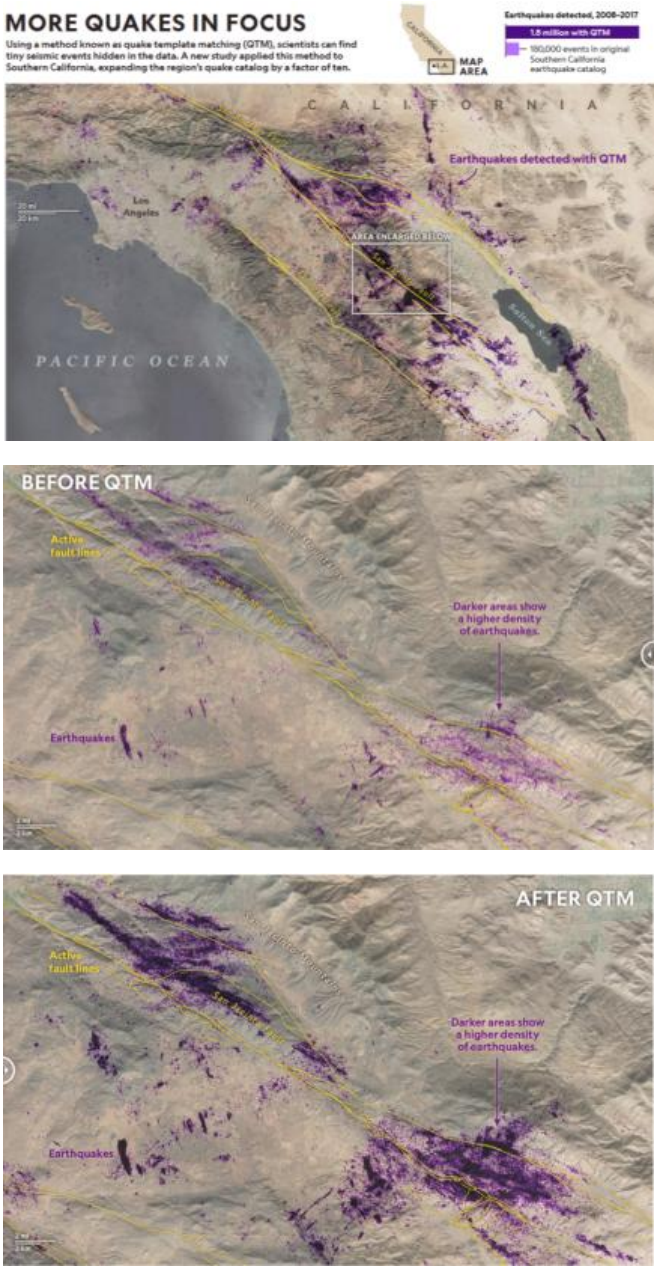
And without any way to reliably detect foreshocks and see patterns, scientists could only forecast when earthquakes might occur over long time periods, based on statistical probability.

Quaking questions

That's why the new quake catalog presented such a tantalizing opportunity. Published earlier this year in *Science*, that colossal effort pinpointed 1.81 million earthquakes that shook Southern California between 2008 and 2017, all the way down to magnitude 0.3.

"It's basically like having a new microscope: You can see more stuff happening," says study coauthor Zachary Ross, a seismologist at the California Institute of Technology.

In the latest analysis, the team used the catalog and identified sequences of foreshocks for 72 percent of the earthquakes they examined.



The challenge, however, is that the patterns of foreshock timing and strength were unique to each main shock. And this lack of a cookie-cutter template makes it hard to distinguish foreshock sequences from earthquake clusters that were not followed by a big quake.

"We don't know that there is a diagnostic foreshock fingerprint out there to find," says Susan Hough, a seismologist at the U.S. Geologic Survey's Earthquake Center who was not on the study team. It's possible more data from ever more advanced tools will reveal the "missing" foreshocks—or it may uncover something even more perplexing.

"It's interesting to ponder whether or not their results mean that we still just don't have the detection capacity to see the other missing 20-odd percent," Bohon says. "Maybe not every earthquake has a foreshock sequence, and what does that mean?"

First step to improve forecasts

Still, the ability to see patterns emerge for so many events

offers hope for future quake catalogs featuring other fault zones around the world. Almost every seismically active

country has earthquake monitoring programs, so this type of analysis could be repeated elsewhere—especially in Japan, where the seismic data are of the same quality as those for Southern California.

"You can start to imagine a situation where maybe [foreshocks are] happening all the time across the Earth," Ross says. "It's the kind of thing that's going to make people think a lot."

For now, geologists are very careful to note that this result is only a first step, and we're still a long way from forecasting earthquakes with any degree of confidence.

"What we would really like to do is say, Oh, there's a 50-percent chance of a [magnitude] 6 or a 50-percent of a 7, and then it's getting into the realm of weather forecasting and something meaningful," Hough says. "We just aren't anywhere close to that at this point."

Bohon agrees, adding: "Until we fully understand all the nuances of how earthquakes start, we need to learn how to live with earthquakes, so that the communities and the people that live in earthquake country not just survive the earthquake, but thrive in its aftermath."

(Jenny Howard / NATIONAL GEOGRAPHIC, August 13, 2019, https://www.nationalgeographic.com/science/2019/08/earthquakes-groundbreaking-catalog-solved-seismic-mystery-foreshocks-southern-california/?cmpid=org=ngp::mc=crm-email::src=ngp::cmp=editorial::add=Science_20190821&rid=CACBEF8EDF813BDA44C29CE59F746A68)

Pervasive Foreshock Activity Across Southern California

Daniel T. Trugman ans Zachary E. Ross

Abstract

Foreshocks have been documented as preceding less than half of all mainshock earthquakes. These observations are difficult to reconcile with laboratory earthquake experiments and theoretical models of earthquake nucleation, which both suggest that foreshock activity should be nearly ubiquitous. Here we use a state-of-the-art, high-resolution earthquake catalog to study foreshock sequences of magnitude M4 and greater mainshocks in southern California from 2008–2017. This highly complete catalog provides a new opportunity to examine smaller magnitude precursory seismicity. Seventy-two percent of mainshocks within this catalog are preceded by foreshock activity that is significantly elevated compared to the local background seismicity rate. Foreshock sequences vary in duration from several days to weeks, with a median of 16.6 days. The results suggest that foreshock occurrence in nature is more prevalent than previously thought and that our understanding of earthquake nucleation may improve in tandem with advances in our ability to detect small earthquakes.

Plain Language Summary

Earthquakes often occur without warning or detectable precursors. Here we use a new, highly complete earthquake catalog to show that most mainshock earthquakes in southern California are preceded by elevated seismicity rates—foreshocks—in the days and weeks leading up to the event. Many of these foreshock earthquakes are small in magnitude and hence were previously undetected by the seismic network. These observations help bridge the gap between observations of real earth fault systems and laboratory earthquake experiments, where foreshock occurrence is commonly observed.

(Geophysical research Letters, 30 July 2019, https://doi.org/10.1029/2019GL083725, https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2019GL083725#.XUHSMwhaH0w.twitter)

Researchers Reinvent How Bridges Withstand Earthquakes with New Support Column Design

Texas A&M is leading a collaborative NSF funded research effort to investigate the performance of hybrid sliding-rocking (HSR) columns.

Bridges make it possible to get to places faster and more conveniently, but in the face of an earthquake these structures are subject to forces that can cause extensive damage. Dr. Petros Sideris, an assistant professor in the Zachry Department of Civil and Environmental Engineering at Texas A&M University, is leading a collaborative research effort funded by the National Science Foundation (NSF) to investigate the performance of hybrid sliding-rocking (HSR) columns, which provide the same support as conventional bridge infrastructure columns but are more earthquake resistant.

Conventional bridges are cast-in-place monolithic concrete elements that are strong but inflexible. Structural damage in conventional columns, usually caused by a natural disaster, result in cracking damage that would force a bridge to close until repairs are completed. On the other hand, bridges with HSR columns are able to withstand large earthquakes with minimal damage and require only minor repairs, likely without bridge closures. Such infrastructure not only increases community quality of life, but can also save thousands in taxpayer dollars.

"There are multiple advantages to the public," Sideris said. "By preventing bridge damage we can maintain access to the affected areas immediately after the event for response teams to be easily deployed. This accessibility will further help the affected communities to recover faster. Also, by mitigating losses related to post-event bridge repairs and bridge closures, more funds can be potentially directed to supporting the recovery of the affected communities."

Bridges with HSR columns are more resilient than traditional columns because they have more deformablity, meaning they can more easily alter their shape. Traditional columns are cast as one piece, which means that as the earth shakes and bends, these structures crack like a stick bent at both ends. HSR columns are built as a series of individual concrete segments held together by steel cables that allow for controlled sliding and rocking. This allows the columns to shift and rock without damage, while post-tensioning strands ensure that at the end of an earthquake the columns are pushed back to their original position.

"Our research has shown that hybrid sliding-rocking columns can be very damage resistant," Sideris said.

In the future, Sideris plans to investigate other aspects of the new design, such as how resistant HSR columns are to vehicular impact. Utilizing feedback from an expert panel of engineers from academia and industry, the team is also investigating potential repair strategies for the HSR column

design in comparison to strategies used for conventional bridge columns.

"Selecting the best repair strategy after an earthquake is no easy task because, on the one hand, it affects the direct repair costs and bridge downtime, while, on the other hand, affects the future performance of the bridge in future earthquakes," Sideris said. "For a new design, such as the hybrid sliding-rocking columns, this can be even more challenging."

"Working on projects such as this that help people, and help making their lives better during difficult times, has always been meaningful and fulfilling for me," Sideris added.

(Robert (Chris) Scoggins, Texas A&M University, College of Engineering August 2, 2019, https://today.tamu.edu/2019/08/02/researchers-reinvent-how-bridges-withstand-earthquakes-with-new-support-column-design/)

Αντισεισμική προστασία: άγνοια και αμέλεια

Σταύρος Α. Αναγνωστόπουλος*

Τα τελευταία 20 χρόνια γίναμε μάρτυρες πολλών φυσικών καταστροφών, όπως οι σεισμοί του 1999 της Αθήνας (148 νεκροί) και του 2008 της Ανδραβίδας (2 νεκροί), οι πλημμύρες της Μάνδρας το 2017 (24 νεκροί) και πρόσφατα, 2019, στη Χαλκιδική (6 νεκροί), οι πυρκαγιές, το 2007 στην Ηλεία (63 νεκροί) και το 2018 στο Μάτι (102 νεκροί) κ.λπ. Και ενώ για τις πλημμύρες και τις πυρκαγιές εξαγγέλλονται και συνήθως ξεκινούν έργα αντιμετώπισης μελλοντικής επανάληψης της καταστροφής (π.χ. διευθετήσεις χειμάρρων, αντιπυρικές ζώνες κ.λπ.), για τους σεισμούς, τη φονικότερη και άνευ προειδοποιήσεως από τις φυσικές καταστροφές, οι ενέργειες αντιμετώπισης περιορίζονται στην εκπαίδευση μαθητών ή, μέχρι πριν από λίγα χρόνια, στην κατασπατάληση δημοσίου χρήματος για πρόγνωση. Σημειωτέον ότι για αρκετά χρόνια η χρηματοδότηση για πρόγνωση σεισμών απορροφούσε το μεγαλύτερο μέρος του προϋπολογισμού για την αντιμετώπιση του σεισμικού κινδύνου και γινόταν εκτός των καθιερωμένων διαδικασιών χρηματοδότησης έρευνας, μέσω αλληλογραφίας της ομάδας ΒΑΝ με τον πρωθυπουργό Ανδρέα Παπανδρέου ή τον υπουργό Δημ. Εργων Ακη Τσοχατζόπουλο (για το φαινόμενο ΒΑΝ είχαμε επισημάνει τις ευθύνες των αρμοδίων.

Δεδομένου ότι, τουλάχιστον για το εγγύς μέλλον, βραχείας διαρκείας πρόγνωση σεισμών δεν είναι πρακτικά αξιοποιήσιμη, υπό την έννοια της προληπτικής εκκένωσης οικοδομών, ο μοναδικός τρόπος αντιμετώπισης της σεισμικής απειλής είναι οι ασφαλείς αντισεισμικές κατασκευές, αρμοδιότητα κατ' εξοχήν των μηχανικών. Δυστυχώς στη χώρα μας συγχέεται ο ρόλος των γεωλόγων - σεισμολόγων, των οποίων η εξειδίκευση εστιάζεται στη χωρική και χρονική εξέλιξη μιας σεισμικής ακολουθίας και σταματάει στον καθορισμό της σεισμικής κίνησης στο βραχώδες υπόστρωμα, ενώ η σεισμική φόρτιση των κατασκευών και η αντισεισμική προστασία είναι κατά κύριο λόγο αρμοδιότητα του πολιτικού μηχανικού, ο οποίος επιπλέον γνωρίζει πώς να αντιμετωπίζει και τις αβεβαιότητες των σεισμικών κινήσεων των σεισμο-γεωλόγων, συνήθως διαφωνούντων στα τηλεοπτικά παράθυρα!

Ενα μεγάλο βήμα για την αντισεισμική ασφάλεια είναι ο νέος αντισεισμικός κανονισμός που υιοθετήθηκε το 2000, ο αντισεισμικός ευρωκώδικας, αλλά και οι τροποποιήσεις που έγιναν το 1984 στον παλιό μας κανονισμό, μετά τους καταστροφικούς σεισμούς της Θεσσαλονίκης του 1978 και της Αθήνας το 1981. Δυστυχώς, κτίρια που μελετήθηκαν και κατασκευάστηκαν πριν από το 1984 με τους κανονισμούς του 1955 και τον αντισεισμικό του 1959, που όχι μόνο υστερούσαν από πλευράς σύγχρονης γνώσης αλλά επιπλέον σπάνια εφαρμόζονταν κατά γράμμα (προς μεγιστοποίηση του εργολαβικού κέρδους), είναι ανασφαλή.

Ιδιαιτέρως προβληματικά είναι τα παλιά κτίρια με πιλοτές, των οποίων το «ανοικτό» ισόγειο σε συνδυασμό με τους διαβρωμένους οπλισμούς των στύλων οδηγεί σε αντοχές πολύ μικρότερες π.χ. 5-15 φορές από αυτές των σύγχρονων κτιρίων. Παρά τις υπηρεσιακές (1) και δημόσιες (2) επισημάνσεις μας, οι αρμόδιες αρχές κωφεύουν, αγνοώντας τα εξής σημαντικά στοιχεία: (α) Οι οικοδομές αυτές παρουσιάζουν τον μεγαλύτερο κίνδυνο και τον μεγαλύτερο αναμενόμενο αριθμό θυμάτων σε μελλοντικούς σεισμούς, κάτι που οι ένοικοί τους αγνοούν. (β) Οι ένοικοι αυτοί δεν φέρουν καμία ευθύνη διότι ουδέποτε παρανόμησαν. (γ) Οι αναγκαίες ενισχύσεις, ήδη κοστολογημένες, είναι πολύ οικονομικές και εύκολες, διότι μπορούν να περιοριστούν στο ανοικτό ισόγειο, και επομένως δεν απαιτούν προσωρινή μεταστέγαση ενοίκων (μέγιστο πρόβλημα για οικοδομές με κλειστά ισόγεια). Επισημαίνουμε εδώ ότι οι ενισχύσεις αυτές, παρόλο που δεν πετυχαίνουν τα επίπεδα ασφάλειας των σύγχρονων κανονισμών (αυτό θα απαιτούσε εκτεταμένες επεμβάσεις και μεταστέγαση ενοίκων), θεραπεύουν την αχίλλειο πτέρνα της πιλοτής. Σχετικές μελέτες έχουν δώσει πολύ μικρά αντιπροσωπευτικά κόστη, τα οποία, συνδυαζόμενα με φορολογικά κίνητρα ή και με ένταξη σε κοινοτικά προγράμματα, όπως το «Εξοικονομώ κατ' οίκον», ελαχιστοποιούν τη δαπάνη ιδιοκτητών και Δημοσίου.

Δυστυχώς οι αρμόδιοι και οι σύμβουλοί τους θεωρούν σημαντικότερη την ίδρυση νέου αντισεισμικού φορέα, αγνοώντας τα ανωτέρω και την ιδιαίτερη ώθηση που θα δινόταν στην οικοδομική δραστηριότητα προς όφελος της οικονομίας της χώρας. Οταν όμως θρηνήσουμε θύματα από κατάρρευση τέτοιων κτιρίων, δεν θα υπάρχει δικαιολογία για κανέναν.

1. Εγγραφο ΟΑΣΠ προς ΥΠΕΧΩΔΕ, Α.Π. 1329/18.7.2008

2. http://www.tanea.gr/opinions/all-opinions/article/5489238/stis-plhmmyres-apotyxame-mhpws-apotyxoyme-kai-stoys-seismoys/#externaldisquss_div

3. http://www.tovima.gr/opinions/article/?aid=835954 (ΤΟ ΒΗΜΑ 13/10/2016).

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(Η ΚΑΘΗΜΕΡΙΝΗ, 24.08.2019, https://www.kathimerini.gr/1039596/opinion/epikairothta/politikh/antiseismikh-prostasia-agnoia-kai-ameleia)

Most of California's Big Earthquakes Are Preceded by Ghostly 'Foreshocks' Weeks in Advance

Foreshocks — the tiny, sometimes imperceptible tremors that precede massive earthquakes — are way more

common than we thought.

How do earthquakes begin? It's an ancient question — and while scientists have ruled out the vengeful gods blamed over the past few millennia, agreeing that tremors are more a matter of grinding plate tectonics than of Poseidon's wrath, many facets of this seismic puzzle remain murky.

One ongoing mystery is the phenomenon of foreshocks, small, sometimes imperceptible tremors that can precede larger quakes in the same area by several days or weeks. Studies have found that anywhere from 10% to 50% of large earthquakes follow these minishocks. This has led many researchers to wonder whether foreshocks are a geophysical fluke or a standard feature of big quakes that modern instruments just aren't sensitive enough to detect with certainty.

A study published July 30 in the journal Geophysical Research Letters offers compelling new evidence for the second hypothesis. Using the most comprehensive catalogue of earthquake activity in Southern California ever assembled, a team of researchers found that roughly 72% of large (magnitude 4.0 or greater) quakes in the region between 2008 and 2017 followed distinct foreshocks that hit up to a month before the event.

"We're hoping that these observations will help inform improved physical models of how earthquakes get started," lead study author Daniel Trugman, a seismologist at Los Alamos National Laboratory in New Mexico, told Live Science. "With this improved physical understanding, we'll eventually be able to improve earthquake forecasting as well."

Trugman and his colleagues began their hunt for foreshocks by compiling a catalogue of some 284,000 earthquakes detected by various monitoring stations around Southern California between 2008 and 2017. Using a technique called quake template matching (QTM), the researchers trained a computer to recognize the distinct waveform these quakes created, then scoured the records for hints of smaller quakes showing those same vibrational patterns, hints that lay hidden in the constant, rumbling background noise of Earth.

The team turned up more than 1 million additional earthquakes, many of them magnitude 0.0 or less (seismologists measure earthquake magnitude on a logarithmic scale, so a magnitude 0.0 quake would be about 10,000 times weaker than a magnitude 4.0 quake). In total, the researchers expanded their catalogue to include 1.81 million earthquakes, or an average of one quake every 3 seconds over the last 10 years, Trugman said.

From this expanded list, the researchers picked 46 quakes with magnitude 4.0 or higher to study for foreshock activity. But first, the team had to calculate the average number of earthquakes near each fault line in Southern California.

"If you pick any point in Earth's crust, especially near an active fault zone, there's going to be a background rate of seismicity," Trugman said. "To show that there are foreshocks, you have to demonstrate that there are more earthquakes than you'd expect leading up to the larger event."

Armed with these seismic averages, the researchers showed a statistically significant increase in foreshock activity shortly before 33 of the 46 big quakes. Foreshocks activity spiked anywhere from three to 35 days before a mainshock hit, with the average increase in rumbling occurring about 16 days before the big event.

"The results suggest that foreshock occurrence in nature is more prevalent than previously thought," the researchers concluded in their study.

And what about the 28% of quakes that lacked a surge in foreshock activity? Trugman said it's likely that many of those quakes did see foreshocks as well but the researchers just couldn't define them with "99% certainty."

"There are a number of cases where there is an increase in seismic activity, but we're not sure it's statistically significant," Trugman said. As seismic-monitoring equipment improves, so too should foreshock detection, he said.

Still, Trugman added, some of the big quakes clearly missed such a spike in foreshocks before the heavy rumbling began. And, on the flipside, a vast majority of the tiny quakes he and his team discovered did not precede large earthquakes at all, meaning that simply seeing an increase in seismic activity along a given fault line is not a reliable predictor of a bigger earthquake to come.

"What we show in this paper is that most if not all mainshocks are preceded by elevated seismic activity that cannot be explained as simple background seismicity," Trugman said. "But that is a very different statement from saying that 'most upticks in seismicity are foreshocks that signal that a mainshock is impending'."

This all shows that the processes that initiate earthquakes are "quite variable," Trugman said, reminding us that seismologists are still a good ways away from being able to forecast earthquakes with any certainty. Perhaps we shouldn't let Poseidon off the hook yet after all.

(Brandon Specktor / Planet Earth, 26 August 2019, https://www.livescience.com/earthquake-foreshocks-common-california.html?utm_source=ls-newsletter&utm_medium=email&utm_campaign=20190826-ls)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΓΕΩΛΟΓΙΑ

A Tiny Magma Blob May Rewrite Earth's History of Plate Tectonics

A blob of magma entombed in a bubble smaller than the width of a human hair and found in South Africa may turn back the clock on Earth's first slow dance of the rocky slabs that make up its outer shell.

The chemicals inside that little blob suggest so-called plate tectonics revved up during the first billion years of Earth's existence.

Since the 1950s, scientists have known Earth's crust is made of giant slabs called tectonic plates that float above Earth's molten mantle. These colossal plates meet in subduction zones, where the lighter slab slides under the heavier one into the depths of the mantle. The sinking crust, infused with minerals collected from Earth's surface, melts into magma under the extreme pressures and temperatures of Earth's interior.

When exactly this planetary recycling began has been hotly debated. Estimates range from 1 billion to 4 billion years ago. Now, an international team of scientists has discovered that the subduction of Earth's crust likely began more than 3.5 billion years ago. Their results were published July 15 in the journal Nature.

"Plate tectonics may be the main process on Earth that makes it different from other planets in our solar system and that may be quite significant for the study of life on Earth," said Alexander Sobolev, lead author of the paper and a geochemist at Université Grenoble Alpes in France.

The microscopic bead of cooled magma at the root of their discovery laid dormant for more than 3.3 billion years, protected by its olivine crystal tomb and unaltered by its surrounding environment. It was a time capsule from one of the earliest eons in Earth's history.

The olivine crystal, no bigger than a grain of sand, was found in a komatiite rock, named after the Komati River in South Africa where such rocks were discovered. They formed when extraordinarily hot plumes of magma rose from the mantle to Earth's surface (once magma reaches Earth's surface, it's called lava) during the Archaean period (2.5 billion to 4 billion years ago). These rare rocks are exceptionally precious to geologists because they give a glimpse into the early conditions of Earth's mantle.

The crystal-entombed magma blob was found in a komatiite rock, named after the Komati River (shown here) in South Africa.

To study the tiny magma inclusion, Sobolev and his team remelted the ovaline crystals by heating them to more than 2,700 degrees Fahrenheit (1,500 degrees Celsius) and rapidly cooling them in ice water to form a glassy sample. They then used state-of-the-art instruments to measure the chemical makeup of the glassy magma and determine its origin.

The researchers discovered the magma contained a number of signatures of subducted oceanic crust, including high concentrations of water and chlorine, and low levels of deuterium (a heavy version of hydrogen). They concluded the magma originated in the melted remains of an ancient ocean seafloor.

"If that is the case, it means a lot," Sobolev said. "It means that seawater-altered crust from the surface went down into the mantle nearly 3.3 billion years ago. Because all these processes are slow, you can expect that from the point from when this source went down to the point where it reached the surface again, it took at least 100 to 200 million years. That means this process started within the first billion years of Earth's history."

(Tim Childers 7 August 2019, Planet Earth, https://www.livescience.com/66114-magma-blob-rewrites-history-earth-plate-tectonics.html?utm_source=ls-newsletter&utm_medium=email&utm_campaign=20190807-ls)

Deep hydrous mantle reservoir provides evidence for crustal recycling before 3.3 billion years ago

Alexander V. Sobolev, Evgeny V. Asafov, Andrey A. Gurenko, Nicholas T. Arndt, Valentina G. Batanova, Maxim V. Portnyagin, Dieter Garbe-Schönberg, Allan H. Wilson & Gary R. Byerly

Water strongly influences the physical properties of the mantle and enhances its ability to melt or convect. Its presence can also be used to trace recycling of surface reservoirs down to the deep mantle[1], which makes knowledge of the water content in the Earth's interior and its evolution crucial for understanding global geodynamics. Komatiites (MgO-rich ultramafic magmas) result from a high degree of mantle melting at high pressures[2] and thus are excellent probes of the chemical composition and water contents of the deep mantle. An excess of water over elements that

show similar geochemical behaviour during mantle melting (for example, cerium) was recently found in melt inclusions in the most magnesium-rich olivine in 2.7-billion-year-old komatiites from Canada[3] and Zimbabwe[4]. These data were taken as evidence for a deep hydrated mantle reservoir, probably the transition zone, in the Neoarchaean era (2.8 to 2.5 billion years ago). Here we confirm the mantle source of this water by measuring deuterium-to-hydrogen ratios in these melt inclusions and present similar data for 3.3-billion-year-old komatiites from the Barberton greenstone belt. From the hydrogen isotope ratios, we show that the mantle sources of these melts contained excess water, which implies that a deep hydrous mantle reservoir has been present in the Earth's interior since at least the Palaeoarchaean era (3.6 to 3.2 billion years ago). The re-constructed initial hydrogen isotope composition of komatiites is more depleted in deuterium than surface res-ervoirs or typical mantle but resembles that of oceanic crust that was initially altered by seawater and then dehydrated during subduction. Together with an excess of chlorine and depletion of lead in the mantle sources of komatiites, these results indicate that seawater-altered lithosphere recycling into the deep mantle, arguably by subduction, started be-fore 3.3 billion years ago.

Nature **Volume 571**, pages555–559 (2019),
https://www.nature.com/articles/s41586-019-1399-5

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΠΕΡΙΒΑΛΛΟΝ

New wave of smart cities has arrived – and they're nothing like science fiction

Grangegorman campus, Technological University Dublin. Technological University Dublin

An abandoned mine shaft beneath the town of Mansfield, England is an unlikely place to shape the future of cities. But here, researchers from the nearby University of Nottingham are planning to launch a "deep farm" that could produce ten times as much food as farms above ground. Deep farms are an example of what the latest wave of smart cities look like: putting people first by focusing on solving urban problems and improving existing infrastructure, rather than opening shiny new buildings.

These smart cities look nothing like science fiction. In fact, the sleek, futuristic visions often used to promote smart cities tend to alienate residents. Isolated high-tech buildings, streets or cities can foster social inequality, and even free WiFi and bike-sharing schemes mainly benefit the affluent.

So instead of chasing ribbon-cutting opportunities in city centres, planners, community leaders and researchers are coming together to tackle mundane but serious issues, such as improving poor quality housing, safeguarding local food supplies and transitioning to renewable energy.

In my own research, commissioned by the British Council, I looked at how new projects and partnerships with universities in eight European cities are making life better for residents, through the clever use of technology. You may already be living in a smart city – here's what to look out for.

More voices

These new smart cities are getting communities and universities involved, alongside big companies and city authorities. This has helped shift the focus of smart city projects onto the needs of residents. During my interviews in cities across Europe – from Bucharest, Romania to Warsaw, Poland and Zaragoza, Spain – I found that university students and researchers have played an active role in this, consulting with residents and working with city hall to promote cooperation between citizens and local institutions.

Universities produce a wealth of knowledge about the kinds of problems facing cities, and there is often a need to make more people aware of new research, so they can shape it, use it and build on it. In Milan, the City School initiative brings together the Municipality of Milan and six local universities to discuss issues facing the city. Universities take turns to showcase research and activities, and city officials test urban policy ideas with experts.

Students bridging the divide.

But above all, communities are now part of the conversation. The EU-funded Sharing Cities programme, led by city halls and universities in London, Lisbon and Milan, has the audacious goal of proving that at least half of the 15,000 locals affected by improvements have actively participated in the process. As such, city authorities have worked with residents to design and implement smart city technologies including smart lampposts, energy management and e-mobility (smart parking, car sharing, electric charging points and so on) – but also to ensure these changes actually improve their lives.

More complexity

Successful smart city projects blend disciplines, bringing together experts in behavioural change alongside specialists in artificial intelligence and information technologies. Interdisciplinary work can be messy and difficult, it can take longer and may not always work – but when it does, it can bring real benefits to cities.

For instance, Nottingham City Council and Nottingham Trent University have been part of the Remourban regeneration programme, working across sectors with cities around Europe. Homes in the Nottingham suburb of Sneinton have been upgraded with new outside walls and windows, a solar roof and a state of the art heating system - a process that takes just a few days.

The result is improved insulation and reduced energy bills for residents, but also better public health: calculations suggest that bad housing costs the UK's National Health Service (NHS) £1.4 billion a year, and improving the quality of homes can cut visits to local doctors almost by half.

Darmstadt, Germany.

The German city of Darmstadt has worked with citizens, universities, museums and businesses to plan for the future. For smart city projects to be embraced by residents, the benefits of new technologies need to be balanced against the need to manage privacy and security concerns. Darmstadt has set up an ethics advisory committee and has a strong focus on cyber security.

The city was recently crowned winner of the German Digital City competition, and the municipal government is now working with other German cities to share what has worked.

More places

The new wave of smart cities spreads improvements beyond the city centre, with universities from France to Ireland running initiatives to bring residents from surrounding areas onto campus, and take their expertise into local communities.

For instance, when Technological University Dublin and Dublin City Council came together to develop a new campus in the deprived district of Grangegorman, they opened it up to the rest of the city. The community eat with the students in the canteen, new buildings reuse material from the old site, renewable energy is stored locally, with excess power released onto the grid, and signage throughout the campus is the same as the rest of the city, blurring the edges between the university and the city.

Technology can play an important and often decisive role in tackling urban problems. But the smart city of the future is more likely to be defined by quieter upgrades to existing infrastructure and new partnerships that better represent residents, than flashy new developments that resemble visions from science fiction.

(THE CONVERSATION, July 19, 2019, https://theconversation.com/new-wave-of-smart-cities-has-arrived-and-theyre-nothing-like-science-fiction-119855)

Heat from the London Underground will be used to heat 1350 homes

In what sounds like an amazing use of energy, heat from the London Underground will soon be used in 1350 homes in London.

Heat from the London Underground will soon be used in 1350 homes in London.

Waste heat from one of the tube lines will be channelled from the Northern Line to support the London Borough of Islington's district heating. This will provide local homes with heat by the end of the year, as well as offices and leisure centres. Islington Council is hoping that the system will make the area more self-sufficient in energy, reduce carbon emissions and lower heating bills for residents. Another advantage for travellers who find the heat stifling on certain Underground lines is that the new initiative should lead to cooler tunnels.

Waste heat from one of the tube lines will be channelled from the Northern Line to support district heating.

The central source of the heat network, named Bunhill 2, is a ventilator shaft used to expel waste heat in the abandoned City Road tube station. A heat pump designed by engineering firm, Ramboll, will capture excess heat from the shaft, which will be warmed to approximately 70 degrees Celsius and transferred into Islington's heat network to supply heat and hot water to local buildings. The system is designed to be reversed in warmer months so that it can pipe colder air into the tube tunnels to keep passengers cool.

In warmer months, the system can pipe colder air into the tube tunnels to keep passengers cool.

The project is part of a scheme to provide cheaper and greener heat to buildings in the area, many of which are existing council housing and leisure centres built between the 1930s and 1980s. It's the second phase of Islington Council's Bunhill Heat and Power scheme, and is being run by the council in conjunction with Ramboll and Transport for London. "We believe that the use of large-scale heat in this way connected to urban district heating systems will play a major part in decarbonising the UK's heating energy de-

mand," says Lucy Padfield, director of district heating at Ramboll.

Heat from the London Underground will soon be used in 1350 homes in London.

It is anticipated that Bunhill 2 district heating system will commence operations in late 2019.

(Andrea Smith / *Lonely Planet Writer*, 30 August 2019, https://www.lonelyplanet.com/articles/london-underground-heat-homes)

ΝΕΕΣ ΕΚΔΟΣΕΙΣ ΣΤΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΠΙΣΤΗΜΕΣ

Breakthrough Issue 5

Welcome to the 5th edition of Breakthrough, the International Tunnelling and Underground Space Association's Young Members group's (ITAYM) initiative to promote opportunities for the next generation of tunnellers.

Published in: 2019 Author: ITAYM

Published in Young Members Publications

Download document Breakthrough_5.pdf

More in this category: « Breakthrough Issue 1

Guide to Pavement Technology Part 5: Pavement Evaluation and Treatment Design

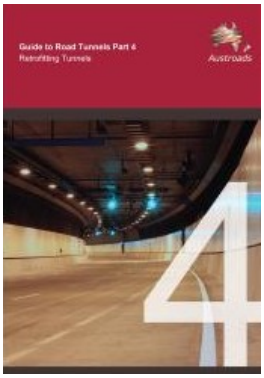
Guide to Pavement Technology Part 5: Pavement Evaluation and Treatment Design provides advice for the investigation of existing sealed road pavements and the selection and design of pavement strategies/treatments. It covers pavement investigation, testing and evaluation, identification of causes and modes of distress, and treatment options.

Knowledge of pavement technology is of critical importance for all transport agencies in Australia and New Zealand. Austroads and others (e.g. state road agencies, local government and industry) have amassed a great deal of knowledge on pavement technologies, techniques and considerations. The purpose of the Austroads *Guide to Pavement Technology* is to assemble this knowledge into a single authoritative guide that will be a readily available, accessible and comprehensive resource for practitioners in Australia and New Zealand.

The target audience for the Austroads *Guide to Pavement Technology* includes all those involved with the management of roads, including industry and students seeking to learn more about the fundamental concepts, principles, issues and procedures associated with pavement technology.

The advice has been generally developed from the approaches followed by Austroads' member authorities. However, as it encompasses the wide range of materials and conditions found in Australia and New Zealand, some parts are broadly based. Treatment selection is related to availability of materials and knowledge of their performance in any particular locality.

https://austroads.com.au/publications/pavement/agpt05/media/AGPT05-19_Guide-to-Pavement-Technology-Part-5-Pavement-Evaluation.pdf



Guide to Road Tunnels Part 4: Retrofitting Tunnels

Guide to Road Tunnels Part 4 provides guidance on the retrofitting of existing tunnels, including the need for refurbishment, the types of refurbishment and processes for developing project requirements. Guidance is provided on geometric considerations relating to cross-sections, traffic management functions including signs and lighting, fire and life safety including fire protection and evacuation, mechanical systems including pumps and lifts, electronic systems including power supply and energy efficiency.

https://austroads.com.au/publications/tunnels/agrt04/media/AGRT04-19_Guide_to_Road_Tunnels_Part_4_Retrofitting_Tunnels.pdf

Environmental Geotechnics in Practice:
Introduction and case studies

Robert W. Sarsby

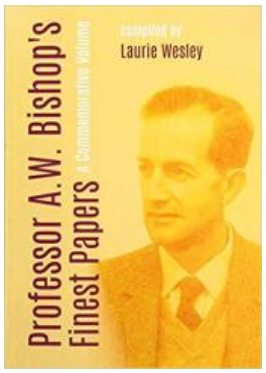
Environmental Geotechnics in Practice is an informative and practical guide to the study of land-based waste disposal. The book identifies the key elements of a variety of waste disposal systems, and explains their role in protecting the environment. Using the most significant case histories from across the world where key lessons have been learned the book provides an engaging introduction to this important field.

The cases described all concern land-based waste disposal sites where there is significant interaction between ground engineering and the environment. Together they demonstrate that whatever the type of waste being disposed of it is possible to use geotechnical principles and practices to design a suitable facility. The author explains how the lessons from these historical cases can help current designers and constructers of waste disposal facilities to address the problems posed by climate change and land shortage. The book provides a broad coverage of environmental geotechnics relating to the performance of landfill sites, treatment of contaminated and damaged land, and stability of waste dumps (tips, tailings and lagoons).

Environmental Geotechnics in Practice will encourage readers to critically appraise the applicability of any design con-

cept and data for the whole lifetime of a waste disposal project. The book will be of interest to a wide readership including professionals working in geotechnical engineering, environmental scientists, geology, and waste management, and also students of these subject areas.

(ICE Publishing, 05 September 2019)

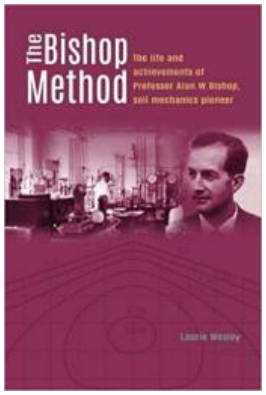


Professor A. W. Bishop's Finest Papers:
A Commemorative Volume 31

Laurie Wesley

This volume brings together a selection of key papers by this soil mechanics pioneer. The papers have been selected on the basis of their importance in the development of soil mechanics and to highlight the nature and range of subjects that Bishop investigated during the thirty-seven years of his career. Bishop's most influential paper was presented at an ASCE (American Society of Civil Engineers) conference in Boulder, Colorado, in 1960, and while it made a big impression at the time, it is now in danger of disappearing from sight. In addition, two of Bishop's very significant papers were published in the late 1970s in the Philosophical Transactions of the Royal Society, not normal reading for the soil mechanics fraternity, and thus became known to only a few people. That has remained the case to this day, and the fact that these two papers have not been republished was the initial motivation for creating this volume. In addition, it is nearly 40 years since Bishop retired from his professorial position at Imperial College and a fitting time to remember Bishop with both a biography, The Bishop Method, and this volume of his papers. In addition to the Bishop papers, there is a paper by Laurie Wesley and Richard Pugh reflecting their research with Bishop. Separate papers were to have been written after the completion of their PhDs, with Bishop as the lead author, but because of his illness this didn't happen. The opportunity has now been taken to present the comprehensive research in these papers, as a tribute to their supervisor and mentor.

(Whittles Publishing, 31 July 2019)



The Bishop Method:
The life and achievements of Professor Alan Bishop, soil mechanics pioneer

Laurie Wesley

Bishop is undoubtedly one of the most widely-known names in the soil mechanics, or geotechnical engineering, community today, alongside the 'founding father', Karl Terzaghi. This is mainly due to the method Bishop devised for estimating the stability of soil slopes; it became known as The Bishop Method and immortalised his name. However, Bishop's contributions to the development of soil mechanics were far wider and of greater significance than his slope stability `method'. His colleague, Professor Skempton, makes this very clear in his contribution to the Bishop eulogy published in Geotechnique in 1988. ...It was a great privilege and the best of good luck to be associated for nearly 40 years with one of the finest intellects in our subject ... his work in this field brought about a highly beneficial revolution in soil mechanics... He was loved and respected by his numerous students... Through them and the strict but friendly criticism of his colleagues' work, and his own important contributions, he exerted a unique influence. Bishop began his career in 1943 when the new soil mechanics world was still grappling with the fundamental issue of soil shear strength. Even the great Terzaghi had not sorted this out. Bishop applied himself immediately to this problem and by the mid 1950s had largely solved it. He published his findings in 1960 in a paper co-authored with Lauritz Bjerrum. This established the parameters to be determined by triaxial testing and the two methods of analysis in use today. This was undoubtedly Bishop's most influential paper. In the eyes of many people Bishop did not receive the recognition he deserved during his lifetime, and indeed has not received since. However, The Bishop Method makes it clear just how influential and important Bishop's contributions were to soil mechanics. The book comprises three parts: Part 1 - the story of Bishop's life, emphasising his particular problem-solving skills Part 2 - his contribution to soil mechanics in some detail, of particular interest to anyone with a technical/professional perspective Part 3 - articles by past students and others who knew him which together paint a fascinating picture of the man.

(Whittles Publishing, 31 July 2019)

ΗΛΕΚΤΡΟΝΙΚΑ ΠΕΡΙΟΔΙΚΑ

https://www.issmge.org/filemanager/article/674/ISSMGE_BULLETIN_2019_AUG_FINAL.pdf

Κυκλοφόρησε το Τεύχος No. 4 του Τόμου 13 (Αυγούστου 2019) του ISSMGE Bulletin της International Society for Soil Mechanics and Geotechnical Engineering με τα παρακάτω περιεχόμενα:

News from Board Member
Young Member Arena
TC corner
Conference reports
- The 2nd International Workshop on Machine Learning and Big Data in Geoscience, China
- The International Conference on Transportation Soil Engineering in Cold Regions, Russia

ISSMGE Foundation reports
Hot news
- Two new books about Prof. A.W. Bishop
- ISSMGE Bright Spark Lecture award – Call for nomination

Event Diary
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International Journal of Geoengineering Case Histories

Volume 5 Issue 1
www.geocasehistoriesjournal.org/pub/issue/view/43

Κυκλοφόρησε το Τεύχος 1 του Τόμου 5 του International Journal of Geoengineering Case Histories με τα παρακάτω περιεχόμενα:

Editorial Adrian Russell, Bernardo Caicedo, David Toll

A Lightweight Soil Nail Retaining Wall in Unsaturated Clay Richard Herraman

Numerical Simulation of the Mechanical Behavior of Single Piles in Expansive Soil Yunlong Liu, Sai K. Vanapalli, Christ-Fabel Nyambere, Hamze Mohamoud

Geobarrier System for Protection Against Rainfall-induced Slope Failure Harianto Rahardjo, Alfrendo Satyanaga, Nurly Gofar, Eng Choon Leong, Jernice Huiling Kew, Chien Looi Wang, Johnny Liang Heng Wong

Numerical Simulation of Capillary Barrier System under Rainfall Infiltration in Singapore Alfrendo Satyanaga, Harianto Rahardjo, Chai Juay Hua

We are pleased to announce the publication of the 8th issue of the Geo-Trends Review Magazine! The first crowdsourcing-based content magazine in Geotechnical Engineering!

https://www.mygeoworld.com/geotrends/issues/8-august-2019?token=ba27286b6533db933478560a9a768b34&utm_source=geoworld&utm_medium=email&utm_campaign=geotrends-may-2019&utm_content=image

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

IGS NEWSLETTER – August 2019

Helping the world understand the appropriate value and use of geosynthetics

- Message From The President: IGS Regional Conferences – Are You Ready? **Read More**
- Watch: Highlights Of Dr. Nathalie Touze's Giroud Lecture **Read More**
- Watch: Two For a Few With Dr. J P Giroud & Dr. Nathalie Touze **Read More**
- "G8 – 8th National Conference on Geosynthetics" Organized by Turkish Chapter of IGS – May 16-17, 2019 – Istanbul, Turkey **Read More**
- Young Members Committee At The 8th Turkish National Conference on Geosynthetics **Read More**
- Italian Chapter AGI-IGS : New Officers Board Elected **Read More**
- Case Studies: Kaytech Solves Problem at Kazungula Bridge Project **Read More**
- Calendar of Events
  - 3rd ICITG, Guimarães, Portugal | Sept. 29 – Oct. 2, 2019
  - 17th ARCSMGE, Cape Town, South Africa | October 7 – 9, 2019
  - GAP2019, Colorado Springs, Colorado, USA | Nov. 4 – 7, 2019
  - GeoMEast, Cairo, Egypt | November 10 – 14, 2019

- GeoAmericas 2020, Rio de Janeiro, Brazil | April 26 – 29, 2020
- 4th ICTG, Chicago, Illinois, USA | Aug. 30 – Sept. 2, 2020
- EuroGeo 7, Warsaw, Poland | September 6 – 9, 2020
- GeoAsia 2021, Taipei, Taiwan | March 1 – 4, 2021

READ MORE AT GEOSYNTHETICSSOCIETY.ORG

https://www.icevirtuallibrary.com/toc/jgein/26/4

Κυκλοφόρησε το Τεύχος 4 του Τόμου 26 (Αυγούστου 2109) του Geosynthetics International της International Geosynthetics Society με τα παρακάτω περιεχόμενα:

Experimental-numerical assessment of geogrid-EPS systems for protecting buried utilities, M. Abdollahi, S. N. Moghaddas Tafreshi, B. Leshchinsky, 26(4), pp. 333–353

Degradation of an HDPE geomembrane without HALS in chlorinated water, F. B. Abdelaal, R. K. Rowe, 26(4), pp. 354–370

Centrifuge model studies on geocomposite reinforced soil walls subjected to seepage, J. Mamaghanian, B. V. S. Viswanadham, H. R. Razeghi, 26(4), pp. 371–387

Large-scale triaxial compression tests of geocell-reinforced sand, F. Song, H. Liu, B. Yang, J. Zhao, 26(4), pp. 388–395

Evaluation of recycled concrete aggregate backfill for geosynthetic-reinforced MSE walls, A. Soleimanbeigi, B. F. Tanyu, A. H. Aydilek, P. Florio, A. Abbaspour, A. Y. Dayioglu, W. J. Likos, 26(4), pp. 396–412

Calibration of PET strap pullout models using a statistical approach, Y. Miyata, R. J. Bathurst, T. M. Allen, 26(4), pp. 413–427

Resilient response of geosynthetics from cyclic and sustained in-air tensile loading, S. W. Perkins, H. N. Haselton, 26(4), pp. 428–435

Dynamic shear modulus and damping of expanded polystyrene composite soils at low strains, H. M. Gao, X. Li, Z. H. Wang, A. W. Stuedlein, Y. Wang, 26(4), pp. 436–450

ΑΝΑΜΝΗΣΕΙΣ ΔΙΑΚΟΠΩΝ

Πρώτες ανταποκρίσεις!

Δροσερούς χαιρετισμούς από την Ευρυτανία, από το Μυρίκι, από τον «φλύσχη» του Βασίλη Μ.

Μέσα στο μεγαλείο της φύσης. Στα έλατα και τους κέδρους. Μπορούσαν οι νεράιδες να μείνουν αδιάφορες; Να το όνομα του βουνού: Νεραϊδοβούνι, στην πλαγία του βρισκόμαστε.

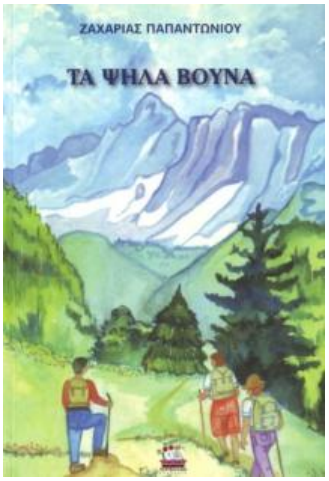
Παντού φλύσχης που αφήνει την βλάστηση να θεριεύει. Μπροστά στον Βορρά, το επιβλητικό Βελούχι η πιο ψηλή κορυφή του Τυμφρηστού, στα +2312. Στα δυτικά η Χελιδώνα στα +1975, με τη εντυπωσιακή σειρά από γεωλογικά λέπη, δείγμα της δύναμης που, από τα ιζήματα της θάλασσας, κτίζει βουνά. Δίπλα, στα νοτιοδυτικά, η Καλιακούδα, στα +2098, με την ογκώδη προεκβολή των κρητιδικών της ασβεστολίθων και τα νερά τους στο αδρεναλίνικο φαράγγι «Πάντα Βρέχει» . Απέναντι ατενίζει κανείς το Καρπενήσι, που ανακτά την χαμένη, παλιότερα, αίγλη που του έχει χαρίσει η μοναδική εδώ φύση. Είμαστε στην λεκάνη του Αχελώου με τα νερά γύρω μας να κυλούν στον Καρπενησιώτη, πριν αυτός ενωθεί με τον Κρικελλοπόταμο, για να καταλήξουν στην τεχνητή λίμνη των Κρεμαστών.

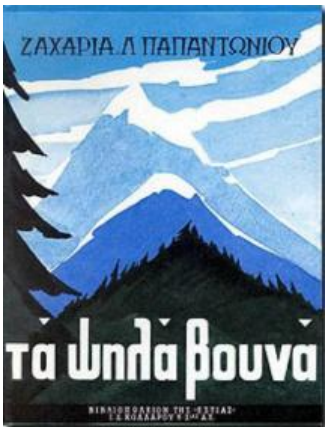
Μυρίκη. Το χωριό δίπλα μας, στα αριστερά της ράχης που βρισκόμαστε. Μέσα στα έλατα. Η ομορφιά της φύσης διάσπαρτη παντού. Το όνομα μάλλον από το μοσχοβόλισμα των ανθέων, πιθανόν της μηλιάς, γιατί λεγόταν πρώτα Μυρίση. Παραφθορά λοιπόν ; Ο θάμνος μυρίκη, πάντως, χρησιμοποιείται, γενικώς, για το αρωμάτισμα της μπύρας. Το σπουδαίο τέμπλο του Αγ. Γεωργίου της, έργο του Στυλ. Υφαντή, παππού του δικού μας Νίκου Παπαδιονυσίου.

Ιστορικές μνήμες σπουδαίες στα γύρω. Αγώνες για την απελευθέρωση από την Οθωμανική κατοχή. Εδώ, στη βάση της πλαγιάς μας, στο Κεφαλόβρυσο, όπου αναβλύζουν τα νερά που διηθούνται τον χειμώνα στον Τυμφρηστό, τραυματίσθηκε θανάσιμα ο Μάρκος Μπότσαρης. Η Μονή της Παναγιάς της Προυσιώτισσας με την θαυματουργή εικόνα, πιο Νότια και ο Καραϊσκάκης. Αγώνες για την απελευθέρωση από την Γερμανική κατοχή. Στις Κορυσχάδες συνεδρίασε τον Μάιο του 1944 το "Εθνικό Συμβούλιο", ως κοινοβούλιο. Και η Μυρίκη έχει το παρών και την προσφορά της στους αγώνες για την ελευθερία. Κάηκε τόσο από τους Τούρκους το 1923 (μετά την μάχη του Κεφαλόβρυσου) όσο και από τους Γερμανούς το 1944.

Στην ράχη όπου και το σπίτι του Βασίλη Μ., έπεσαν, στις 27 Οκτωβρίου του 1942, 3 Άγγλοι κομάντος αλεξιπτωτιστές και ο Έλληνας επικεφαλής τους, ο έφεδρος αξιωματικός Θέμης Μαρίνος, πριν ενωθούν με τους αντάρτες του Ζέρβα και του Βελουχιώτη (μαζί, έτσι και έτσι, τότε) για την επιχείρηση "Harling", της ανατίναξης της γέφυρας του Γοργοποτάμου. Θέμις Μαρίνος εκ Ζακύνθου – συνωνυμία- έφυγε γεμάτος από ημέρες τον Δεκέμβριο του 2018.

Από ανθρώπους των γραμμάτων να περιορισθώ στον Ζαχαρία Παπαντωνίου με «Τα Ψηλά Βουνά» του, μοναδικό έργο στην Ελληνική σχολική λογοτεχνία, μοναδικής φρεσκάδας αναγνωστικό μεστό χωρίς διδακτισμό. Μακριά από κάθε επιτήδευση κοντά στην γνωριμία της φύσης, τις παραδόσεις, στην συνέργεια των ανθρώπων. Για λίγο όμως λειτούργησε σαν τέτοιο (Έκδοση «Εστίας» 40η έκδοση 2012)1. Και ο Στέφανος Γρανίτσας με το εκπληκτικό, για την γνωριμία μας με τα ζώα, «Τα άγρια και τα ήμερα του βουνού και του λόγγου» (Έκδοση «Εστίας», επανέκδοση 1997).





Οι εκδόσεις «Εστία» δεν υπάρχουν πιά, αλλά ευρίσκονται (ελπίζω) σε μεγάλα βιβλιοπωλεία.

Καλή συνέχεια στο καλοκαίρι

Παύλος και Κατερίνα, Αύγουστος 2019

(από το μέλος της ΕΕΕΕΓΜ Ομότιμο Καηγητή ΕΜΠ Παύλο Μαρίνο)

Σεϋχέλλες, Τα ονειρικά νησιά του Ινδικού!

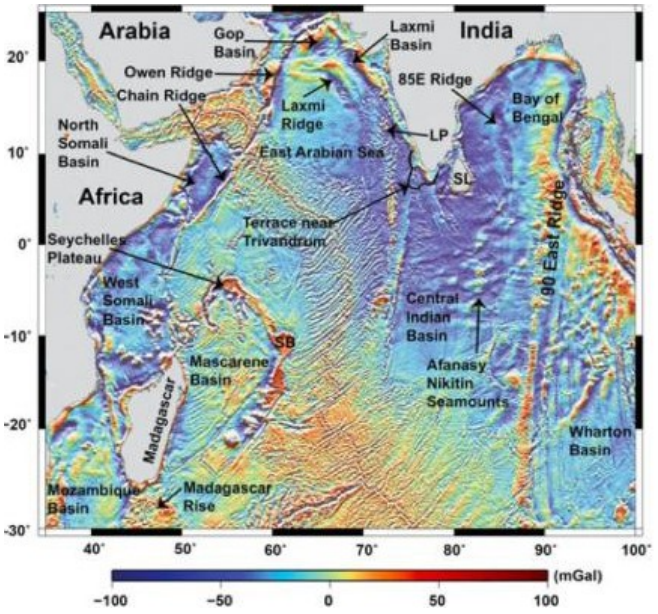
Στον Ινδικό Ωκεανό, 100 περίπου μίλια από τις ακτές της Ανατολικής Αφρικής και της Μαδαγασκάρης, βρίσκονται 115 πάρα πολύ όμορφα γρανιτένια και κοραλλιογενή νησιά. Πρόκειται για το νησιωτικό σύμπλεγμά που ακούει στο… πολύ γνωστό όνομα, Σεϋχέλλες.

Θέση στον παγκόσμιο χάρτη

Πρώτοι έφτασαν στα νησιά οι Πορτογάλοι, στις αρχές του 16ου αιώνα. Από τότε πέρασαν από τα νησιά οι Γάλλοι, στους οποίους οι Σεϋχέλλες οφείλουν το όνομά τους, και οι Άγγλοι, οι οποίοι το 1903 κήρυξαν τις Σεϋχέλλες αγγλική αποικία. Η χώρα απέκτησε την ανεξαρτησία της το 1976.

Γεωλογία και Τεκτονική

Από γεωλογική άποψη οι Σεϋχέλλες παρουσιάζουν διαφορετική μορφολογία σε σχέση με άλλα νησιά της ευρύτερης περιοχής.



Οι Σεϋχέλλες ανήκουν σε μια μικροήπειρο από γρανίτη, η οποία αποσπάστηκε από την υπερήπειρο Gondwana μέσα στα τελευταία 145.000.000 χρόνια και απομονώθηκε στον Ινδικό Ωκεανό. Η μικροήπειρος περιορίστηκε μεταξύ της βόρειας Μαδαγασκάρης και της δυτικής Ινδίας μέχρι το τέλος της Κρητιδικής εποχής και εξελίχθηκε κατά τη διάρκεια του Καινοζωικής μέσω μιας διαδικασίας ρήξης και μετατόπισης. Η μικροήπειρος ανυψώθηκε, διαβρώθηκε και επηρεάστηκε από ηφαιστειακές εκρήξεις.

Τα νησιά δομούνται κυρίως από γρανίτη (Mahe, Praslin, La Digue και Fregate ηλικίας 755 εκατομμυρίων ετών), με μερικές ακολουθίες ιζηματογενών πετρωμάτων. Ο γρανίτης είναι γκρίζος, ενώ στα νοτιοδυτικά συναντάται με την μορφή ροζ πορφυρίτη.

Χαρακτηριστικές φωτογραφίες των σχηματισμών γρανίτη:

και παραλιών από το Mahe…

Χρήστος και Φάνη Τσατσανίφου, Ιούνιος 2018

Οι Σεϋχέλλες αποτελούν μοναδικό τόπο χαλάρωσης και εξωτικής απόδρασης με εξαιρετική τουριστική υποδομή και πολλές δραστηριότητες. Η τροπική βλάστηση οργιάζει και δένει αρμονικά με τους γρανιτένιους βράχους.

Η πρωτεύουσα Βικτώρια ευρίσκεται στο Mahe, το μεγαλύτερο νησί του Αρχιπελάγους, όπου η έδρα της κυβέρνησης και το Διεθνές Αεροδρόμιο (αποικιακού στυλ!). Οι εξαιρετικοί βοτανικοί κήποι, τα περιβόλια με τις ορχιδέες, οι φυτείες με τις σπάνιες καρύδες «coco de mer», οι φυτείες τσαγιού, το φοινικόδασος Vallee de Mai στο νησί Praslin (έχει χαρακτηρισθή από την UNESCO μνημείο παγκόσμιας κληρονομιάς) και οι κατάλευκες παραλίες χαρίζουν στα νησιά μοναδική ειδυλλιακή ατμόσφαιρα.

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