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ΕΛΛΗΝΙΚΗ ΕΠΙΣΤΗΜΟΝΙΚΗ ΕΤΑΙΡΕΙΑ ΕΔΑΦΟΜΗΧΑΝΙΚΗΣ & ΓΕΩΤΕΧΝΙΚΗΣ ΜΗΧΑΝΙΚΗΣ

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Σεισμική απειλή: Πότε το Μάτι και η Μάνδρα θα μας διδάξουν;

Σταύρος Αναγνωστόπουλος

Μέχρι πότε οι «αρμόδιοι» θα αγνοούν τις προειδοποιήσεις των ειδικών για σχεδόν σίγουρες μελλοντικές καταστροφές; Γιατί πρέπει ο δύσμοιρος τούτος τόπος να θρηνεί νεκρούς και τεράστιες καταστροφές, που αν κάποιοι «αρμόδιοι» είχαν κάνει το καθήκον τους θα μπορούσαν να αποφευχθούν; 22 νεκροί στις πλημμύρες της Μάνδρας το 2017, ~100 νεκροί στις πυρκαγιές στο Μάτι στις 23/7/2018, χιλιάδες σπίτια με ζημιές και εκατοντάδες ολικά κατεστραμμένα. ΓΙΑΤΙ; Οι δικαιολογίες βέβαια είναι γνωστές: Ακραία φυσικά φαινόμενα, οι προηγούμενοι δεν έκαναν τίποτα, έλλειψη συντονισμού κλπ. Η πραγματική όμως αιτία δεν είναι άλλη από την παντελή έλλειψη μακροχρόνιου σχεδιασμού, την προχειρότητα που μαστίζει τούτο τον τόπο και την έλλειψη ευαισθησίας των πολιτικών μας για δράσεις με όχι άμεσα και εμφανή αποτελέσματα. Κυρίως σε αυτές, αλλά και σε άλλες παθογένειες του Ελληνικού κράτους, βρίσκονται τα αίτια όλων των μεγάλων φυσικών καταστροφών στη χώρα μας.

Το παρόν άρθρο, παρ' όλο που δεν αναφέρεται σε πυρκαγιές, γράφεται τώρα με την ελπίδα ότι οι νωπές εικόνες

(συνέχεια στην σελίδα 3)

ΠΕΡΙΕΧΟΜΕΝΑ

Η παραλία Τριόπετρα στο Ρέθυμνο

(συνέχεια από την πρώτη σελίδα)

της τραγωδίας στο Μάτι, ίσως επί τέλους ευαισθητοποιήσουν κάποιους αρμόδιους να λάβουν έγκαιρα προληπτικά μέτρα, ώστε να μη θρηνήσουμε νέα θύματα, αυτή τη φορά από σεισμούς, τη μεγαλύτερη απειλή κατά της ανθρώπινης ζωής και περιουσίας στη χώρα μας. Σε σύγκριση με τους νεκρούς των πρόσφατων πυρκαγιών και πλημμυρών, οι νεκροί από τους σημαντικότερους σεισμούς των τελευταίων 60 ετών στη χώρα μας ήταν πολύ περισσότεροι: 831 συνολικά, εκ των οποίων 143 το 1999 στο σεισμό της Αθήνας και 476 το 1953 στους σεισμούς της Κεφαλονιάς.

Ενώ η αποφυγή καταστροφών από πλημμύρες και πυρκαγιές απαιτεί σημαντικές επεμβάσεις σε έργα υποδομής, αντιθέτως, η αποφυγή θυμάτων από σεισμούς απαιτεί κάτι πολύ απλούστερο: ασφαλείς αντισεισμικές κατασκευές. Και ενώ ένα βασικό βήμα για αποφυγή σεισμικών καταστροφών έχει γίνει με τον εκσυγχρονισμό των Κανονισμών μας, το μεγάλο πρόβλημα της σεισμικής ασφάλειας των παλιότερων οικοδομών παραμένει. Από αυτές, τον μεγαλύτερο κίνδυνο αντιμετωπίζουν οι πολυκατοικίες με πιλοτή που κατασκευάστηκαν πριν την πρώτη αναβάθμιση των κανονισμών μας (1984) και κάποτε χαρακτηρίσθηκαν ως ωρολογιακή βόμβα. Για να αντιληφθεί κανείς το πρόβλημα, αρκεί να αναφέρουμε ότι η σεισμική αντοχή των οικοδομών αυτών είναι πολλαπλά μικρότερη από την αντοχή σύγχρονων οικοδομών. Η αμέλεια του κράτους για τη λήψη μέτρων ενίσχυσης των οικοδομών αυτών μόνο ως εγκληματική μπορεί να θεωρηθεί. Και τούτο διότι: (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 είναι πολύ οικονομικές και εύκολες, διότι μπορούν να περιορισθούν στο ανοιχτό ισόγειο, και επομένως δεν απαιτούν προσωρινή μεταστέγαση ενοίκων (ουσιαστικά ανυπέρβλητο πρόβλημα). Επισημαίνουμε εδώ ότι οι ενισχύσεις αυτές, παρ' όλο που δεν πετυχαίνουν τα επίπεδα ασφάλειας των σύγχρονων

Κανονισμών (που θα απαιτούσαν εκτεταμένες επεμβάσεις), θεραπεύουν την αχίλλειο πτέρνα της πιλοτής. Σχετικές μελέτες έχουν δώσει αντιπροσωπευτικά κόστη της τάξεως των 2.000-5.000 ευρώ για ιδιοκτήτη διαμερίσματος 100 τετραγωνικών. Ας συγκριθούν τα ποσά αυτά με τα πολλαπλάσια ποσά που διατίθενται από το κράτος για ανακούφιση πληγέντων από φυσικές καταστροφές. Η κάλυψη της μικρής αυτής, σχετικά, δαπάνης μπορεί να γίνει από τους ιδιοκτήτες των οικοδομών χωρίς οικονομική επιβάρυνση του Δημοσίου. Αρκεί η πολιτεία να λάβει μια σειρά διοικητικών και οικονομικών μέτρων (όπως εισάγοντας χρονικό ορίζοντα, π.χ. 15ετίας, για την ενίσχυση, ρυθμίζοντας νομοθετικά τα της λήψης σχετικής απόφασης ιδιοκτητών πολυκατοικίας, δίνοντας φορολογικά κίνητρα κ.λπ.). Τέτοια μέτρα, ανάλογα προς αυτά της ενεργειακής αναβάθμισης των οικοδομών, θα συνέβαλαν σημαντικά και στην αναζωογόνηση της οικοδομικής δραστηριότητας στη χώρα μας.

Δεν γνωρίζω αν υπήρξαν προειδοποιήσεις για τις τραγωδίες στη Μάνδρα και στο Μάτι. Γνωρίζω όμως ότι για τον σεισμικό κίνδυνο παλιών πολυκατοικιών με πιλοτή, εκτός από δημόσιες παρεμβάσεις σαν την παρούσα, είχε σταλεί σχετικό υπόμνημα το 2008 από τον ΟΑΣΠ προς το υπουργείο Υποδομών (Α. Πρωτ. 1329.18/7/2008) που δυστυχώς αγνοήθηκε. Όπως αγνοείται ότι : Κάθε μέρα που περνάει μάς φέρνει πλησιέστερα στην επόμενη καταστροφή! Πόσο πιο έντονα πρέπει κάποιος να προειδοποιήσει για την εγκληματική αυτή αμέλεια? Οι εισαγγελείς που αναζητούν τα αίτια των διαφόρων φυσικών καταστροφών ας κρατήσουν το παρόν άρθρο στο αρχείο τους.

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(ΤΟ ΒΗΜΑ, 13.09.2018, http://www.to-vima.gr/2018/09/13/opinions/seismiki-apeili-pote-to-mati-kai-i-mandra-tha-mas-didaksoun)

Προσφάτως ο Καθηγητής Paolo Riva - University of Bergamo & Italian Society of Earthquake Engineering παρουσίασε διάλεξη στην Society for Earthquake Engineering and Soil Dynamics (SECED, www.seced.org.uk) με θέμα **Seismic Classification of Building & Tax Breaks: The 2017 Italian Guidelines**, ανάλογο αυτού που θίγει ο Καθηγητής Σταύρος Αναγνωστόπουλος. Το ενδιαφέρον σημείο της διάλεξης ήταν η αναφορά στο ότι το κόστος της επισκευής των κατασκευών μειώνει την φορολογία των ιδιοκτητών όσο περισσότερο μειώνεται η σεισμική διακινδύνευσή τους. Στην Ιταλία, όμως, κινούνται, ενώ εμείς…

Synopsis

The need for urgent and systematic actions to reduce the seismic risk of the Italian building stock is evident from the fact that even relatively small earthquakes are able to induce significant damage.

This highlights the extremely high vulnerability of Italian constructions, most of which are ancient stone or masonry structures, or have been erected in the absence of proper seismic provisions.

In order to significantly improve the scenario, huge financial resources are required. Hence, since funds to investment are limited, an evaluation of the seismic risk of Italian buildings is of paramount importance in order to quantify the required resources, to plan investments and to define prioritization strategies for the seismic risk mitigation.

In 2013 the Ministry of Infrastructures for medaworkgroup, headed by ISI, (The Italian Society of Earthquake Engineering), with the task of defining a method for the Seismic Classification of Buildings. In 2014 the work group submitted to the Italian Minister a draft of the guidelines for a new seismic performance classification framework based on expected annual losses (EAL) which was the basis for the Seismic Risk Classification introduced in Italy in February 2017.

The Classification has a structure similar to the Energy Performance Classification of Buildings and allows ranking the buildings in 7 classes (from A to G). To stimulate the adoption of risk mitigation measures, together with the Seismic Classification, the Italian government has introduced an interesting tax deduction scheme where the amount of deductible costs is based on the level of seismic risk reduction achieved through retro fitting works. The seminar will illustrate both the Italian Seismic Classification of Buildings approach, and the tax deduction scheme that accompanies it.

ΑΡΘΡΑ

Με την ευκαιρία της έναρξης της διαδικασίας μελέτης και κατασκευλης της Γραμμής 4 του Μετρό της Αθήνας, θεωρούμε ότι το άρθρο μπορεί να είναι χρήσιμο στους μελετητές λόγω του ενδιαφέροντός του. Επειδή είναι μακροσκελές, παραθέτουμε την ιστοσελίδα από την οποία μπορεί να αποκτηθή ελεύθερα.

Benefits of pre-loading temporary props for braced excavations

Benoît Latapie, Terry Winarta and Steven David Lloyd

Abstract

Using soil profiles typical of excavations in London, UK and Dubai, UAE calculations have been carried out to compare the performance of temporary steel and proprietary hydraulic propping. Numerical modelling indicates that pre-loading allows the lower-stiffness hydraulic prop to match the performance (in terms of prop load and wall displacement) of a higher-stiffness steel prop, without pre-load. The low prop stiffness also helps to mitigate loading induced by thermal effects. Furthermore, where limiting the horizontal deflection of the wall is critical, the application of a calibrated pre-load can improve the economy of the temporary works by reducing the prop size. Pre-loaded props are sometimes associated with increased bending moment and shear force values in the retaining wall. The finite-element models produced for this paper prove that for the cases considered, the use of pre-loaded low-stiffness hydraulic props achieved the same performance as stiff steel props, with no impact on the wall' s reinforcement. Further work is suggested to explore how manipulating and varying the pre-loading values in multipropped basements might be used to improve further the performance and/or the economy of the retaining wall and how this might affect the load transfer from temporary to permanent supports in the longer term.

Introduction

Shoring is a necessary part of almost every deep basement excavation where retention of soil materials and/or sustaining groundwater pressures is required. The most common construction method uses a 'bottom–up' technique, where the retaining wall is constructed initially and the excavation and installation of the support frames/props proceed downwards in stages. In this situation, the permanent works are constructed from the bottom of the supported excavation, working upwards. An alternative to this is a top–down construction method, which is not in the remit of this paper. The methods used vary greatly in terms of execution, but from a design point of view, they tend to follow a very similar pattern: an embedded retaining wall (e.g. diaphragm wall, secant/contiguous bored pile wall, steel sheet piles) is supported by one or more levels of horizontal beam (e.g. concrete capping beam, steel waling beam), which is in turn supported by a series of props or anchors (e.g. raking props, flying shores, ground anchors). Shallow excavations, which are not in the remit of this paper, are sometimes retained with a retaining wall alone, acting as a cantilever.

In this paper, numerical modelling of deep propped excavations is used to investigate the potential benefits of pre-loading (or pre-stressing) the structural supports on the performance of the temporary work system. Different excavation depths and ground conditions are considered in order to ensure that the conclusions drawn in this paper are not reliant on conveniently chosen assumptions. Using past experience in both Dubai (UAE) and London (UK), representative temporary work scenarios were recreated and used in the analyses. The paper demonstrates that carefully selected values of pre-load may be used as substitutes for inherent prop stiffness. A discussion on the benefits of using props with lower stiffness, particularly with regard to dealing with the effect of temperature, is also included. Ground anchors and other support methods are not considered in this paper. Proprietary hydraulic props are used when analysing the scenarios where pre-load is introduced in the support system

Figure 1. Proprietary hydraulic props in service

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The 2015 landslide and tsunami in Taan Fiord, Alaska

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Abstract

Glacial retreat in recent decades has exposed unstable slopes and allowed deep water to extend beneath some of those slopes. Slope failure at the terminus of Tyndall Glacier on 17 October 2015 sent 180 million tons of rock into Taan Fiord, Alaska. The resulting tsunami reached elevations as high as 193 m, one of the highest tsunami runups ever documented worldwide. Precursory deformation began decades before failure, and the event left a distinct sedimentary record, showing that geologic evidence can help understand past occurrences of similar events, and might provide forewarning. The event was detected within hours through automated seismological techniques, which also estimated the mass and direction of the slide - all of which were later confirmed by remote sensing. Our field observations provide a benchmark for modeling landslide and tsunami hazards. Inverse and forward modeling can provide the framework of a detailed understanding of the geologic and hazards implications of similar events. Our results call attention to an indirect effect of climate change that is increasing the frequency and magnitude of natural hazards near glaciated mountains.

Introduction

Climate change is driving worldwide glacial retreat and thinning[1] that can expose unstable hillslopes. The removal of glacial ice supporting steep slopes combined with the thawing of permafrost in alpine regions[2] increases the likelihood of landslides[3,4,5,6]. Glaciers undercut slopes, priming them for failure by deepening and widening valley bottoms, and by producing steeper valley walls[7]. Additionally, ice loading produces stress fractures in the underlying bedrock, further preparing slopes for failure[8]. As climate warms and glaciers shrink and retreat, they can no longer support rock slopes, and fractures expand as stresses are released. This slope conditioning leads to rock falls, deep-seated gravitational slope deformation, and occasionally catastrophic rock avalanches[4,9,10].

A further effect of glacial retreat is the creation or extension of bodies of deep water, fresh or marine[11,12], where tsunamis can be generated efficiently (Table 1). Along the glacially sculpted coastlines of Alaska, Patagonia, Norway, and Greenland, communities, tourism, and infrastructure are becoming increasingly exposed to such landslides and the tsunamis they may generate. Tsunamis in lakes can create flood risk downstream by flowing into inhabited downstream valleys (e.g.[13,14,15]).

Table 1 Tsunamis with runup of 50 m or greater in the past century.

From: The 2015 landslide and tsunami in Taan Fiord, Alaska

Year	Location	Water body	Cause	Latitude	Longitude	Max runup (m)
1958	Lituya Bay, Alaska, USA	Fjord	Subaerial landslide	58.672	−137.526	524
1980	Spirit Lake, WA, USA	Lake	Volcanic landslide	46.273	−122.135	250
1963	Casso, Italy	Reservoir	Subaerial landslide	46.272	12.331	235
2015	**Taan Fiord, Alaska, USA**	**Fjord**	**Subaerial landslide**	**60.2**	**−141.1**	**193**
1936	Lituya Bay, Alaska, USA	Fjord	Subaerial landslide	58.64	−137.57	149
2017	Nuugaatsiaq, Greenland	Fjord	Subaerial landslide	71.8	−52.5	90
1936	Nesodden, Norway	Fjord	Subaerial landslide	61.87	6.851	74
1964	Cliff Mine, Alaska, USA	Fjord	Delta-front failure	61.125	−146.5	67
1934	Tafjord, Norway	Fjord	Subaerial landslide	62.27	7.39	62
1965	Lago Cabrera, Chile	Lake	Subaerial landslide	−41.8666	−72.4635	60
1967	Grewingk Lake, Alaska, USA	Lake	Subaerial landslide	59.6	−151.1	60
1946	Mt. Colonel Foster, BC, Canada	Lake	Subaerial landslide	49.758	−125.85	51
2004	Labuhan, Indonesia	Open coast	Earthquake displacement	5.429	95.234	51
2000	Paatuut, Greenland	Fjord	Subaerial landslide	70.25	−52.75	50

10 out of 14 tsunamis resulted from subaerial landslides into fjords or lakes in glaciated mountains. Other cases have diverse causes: volcanic eruption (1980), landslide into artificial reservoir (1963), subaqueous delta failure (1964), and earthquake displacement (2004). (Data modified from[53]).

Tsunamis triggered by landslide impact can have an order of magnitude shorter periods and higher runups than those driven by tectonics that have dominated tsunami hazard research in recent years[16]. While tectonic tsunamis typically have periods in the tens of minutes and peak runups extending up to around 30 m, the best studied landslide tsunami, which occurred in 1958 in Alaska's Lituya Bay, had a period of about 76 seconds and peak runup of 524 m[17]. The geologic traces of the Lituya Bay landslide and tsunami have not been documented, providing no analogue for identification of ancient short-period, large-runup tsunamis in the geologic record, be they caused by landslides, volcanoes, or meteor impacts. The only field data available to constrain these reconstructions are the deposits of the 2000 AD landslide-triggered tsunami in Vaigat Strait, West Greenland[18], and surficial descriptions of deposits from the tsunami in Grewingk Lake in 1967[19]. The event we describe here in Taan Fiord, Alaska provides the best example to date of a well-documented subaerial landslide that generated a tsunami, and of its impacts on a fjord, coupled with detailed examination of its deposits (see Supplementary Fig. online). This study provides crucial insight into landslide-triggered tsunami processes and the various traces of such events.

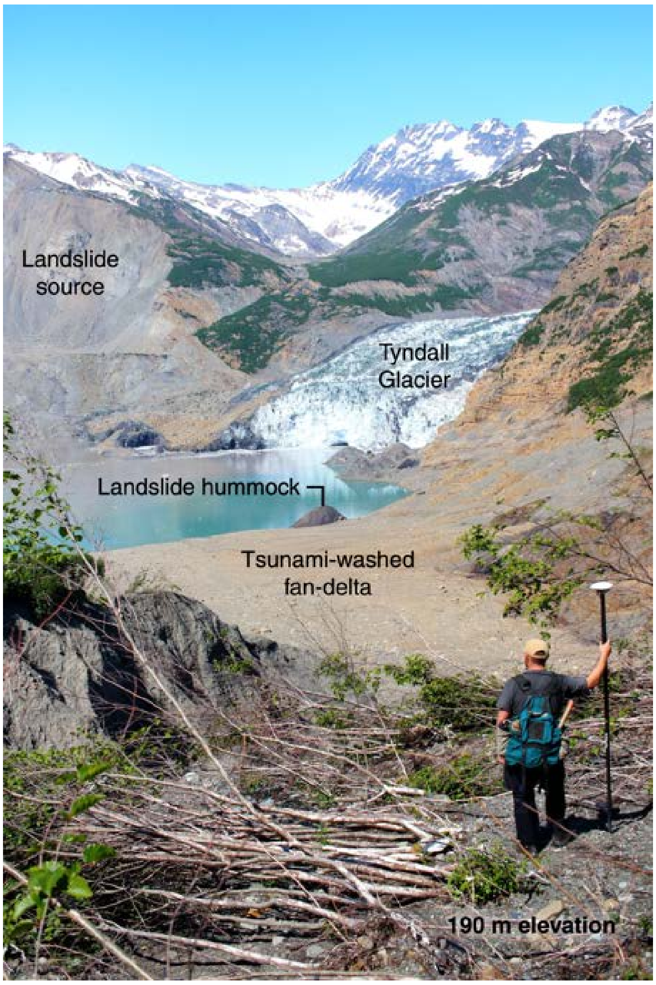

Figure 1. Tsunami impacts near the landslide. The 2015 landslide and tsunami reshaped the landscape at the terminus of Tyndall Glacier. The person in the photo is standing about 190 m above the fjord level, just below the limit of inundation (near the point marked with 193 m runup in Fig. 2).

The 2015 Taan Fiord landslide

On 17 October 2015, a massive landslide and tsunami occurred at the head of Taan Fiord, an arm of Icy Bay within Wrangell-St. Elias National Park & Preserve in Alaska (Fig. 1).

The slope failure was primed by rapid ice loss from a tidewater glacier in a tectonically active setting. Tyndall Glacier filled Taan Fiord as recently as 1961[20]. Rapid warming over the past half century led to 17 km of terminus retreat and over 400 m of ice thinning between 1961 and 1991. Since 1991, the terminus of Tyndall Glacier has stabilized at a shallow bedrock constriction at the head of the fjord[20,21] (Fig. 2). The slope that failed was above the calving front and slid directly into the fjord along the terminus, partially covering the toe of the glacier. Destruction of vegetation and other tsunami traces clearly delineate runup throughout the fjord. Directly across from the landslide, runup reached 193 m, (as compared to 240 m in an initial model estimate[22]). Runup exceeded 100 m for 1.5 km, overrunning over 1 km^2 of area. Further down-fjord, Runup varied dramatically, but generally declined to about 15 m at the mouth of the 17 km long fjord (Fig. 2).

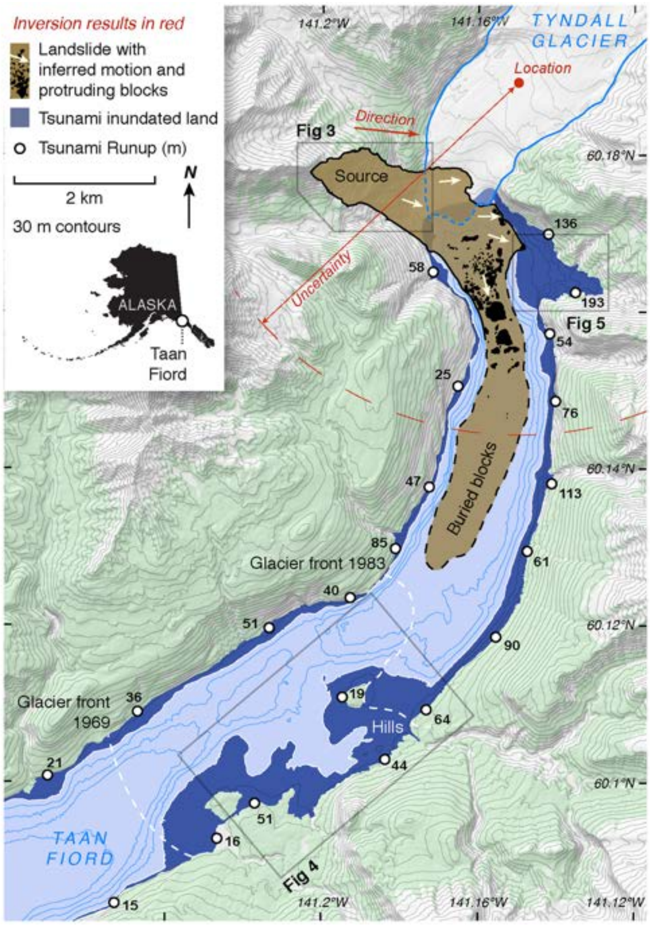

Figure 2. Changes in Taan Fiord. Tyndall Glacier retreated at an increasing pace through the late 20th century until it stabilized in 1991, at approximately the location of the current terminus. The slope failure in October 2015 entered the recently deglaciated fjord at the calving front, generating a tsunami that swept the coast to a height of 193 m. Seismic inversion completed within hours of the event produced an accurate picture of initial motion and a rough location, but could not determine whether the landslide had set off a tsunami. In 2016, marine surveys revealed tens of meters thick blocky submarine runout extending several kilometers[28]. Only the more proximal blocks form submarine hillocks, while more distant ones are buried beneath one or possibly two post-landslide turbidites[28]. Field surveys mapped runup, selected examples of which are presented here. Map created with QGIS 2.18 (http://www.qgis.org/en/site/).

Ongoing tectonic deformation likely contributed to the Taan Fiord landslide. The present-day glacier terminus lies along the east-west oriented Chaix Hills Fault, one of many structures that accommodate rapid (4–5 mm a^{-1}) tectonic uplift of poorly lithified Miocene-Holocene rocks to high elevations in the St. Elias orogen[21,23]. Uplift of weak and faulted rock likely intensified glacial erosion, leading to rapid valley excavation. Subsequent glacial retreat debuttressed the oversteepened fjord wall, initiating progressive failure of the slope that eventually culminated in catastrophic collapse and a tsunami.

Signs of prior hillslope deformation at the location of the 2015 landslide might have provided forewarning. Slumping along the fjord wall at the site was first identified in 1996[21] and grabens are visible in Landsat images as early as 1995. A comparison of Digital Elevation Models (DEMs) and optical satellite imagery show downslope motion throughout much of the ensuing two decades until the catastrophic failure in October 2015 (Fig. 3). While the 2015 Taan Fiord landslide and tsunami did not result in fatalities, actively deforming slopes in more populated places (e.g. Tidal Inlet, Glacier Bay National Park, Alaska[24]) may be harbingers of more deadly landslide-generated tsunamis in the future. Monitoring gradual downslope motion in mountain ranges around the world, while a technical challenge, would provide a step forward in our ability to mitigate risk.

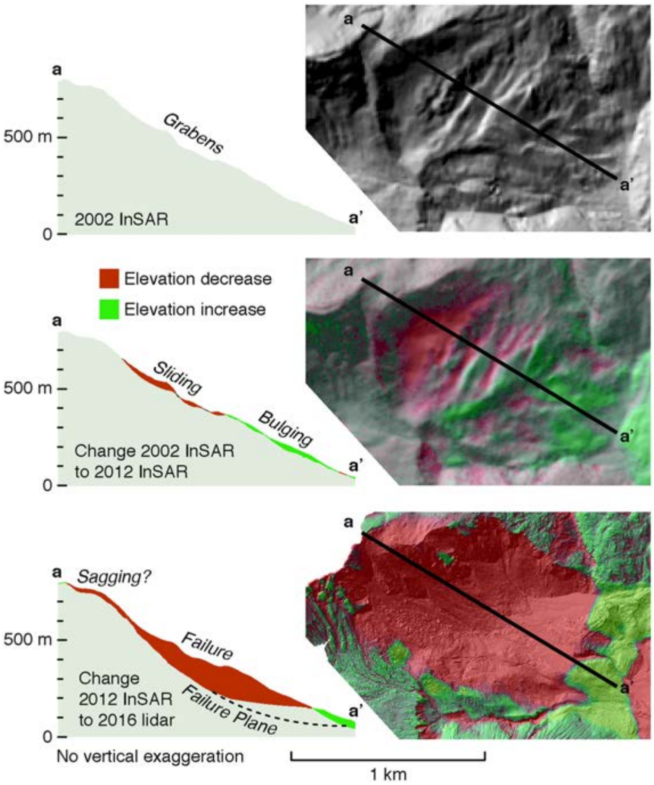

Figure 2. Motion began decades prior to failure. Signs of slope failure in the landslide source area (Fig. 1) were first noted in 1996[19]. Further motion occurred between 2002 and 2012, and the landslide occurred in 2015. Landsat imagery aligned and animated through Google Earth Engine[52] shows motion progressing yearly during a sequence of images from 1995 to 1998, and that some motion motion (less rapid than 1995 to 1998) occurred between 2010 and 2015. Other portions of the image sequence are too unclear to tell whether motion occurred. The lower panel includes an inferred failure plane from 25. Maps created with QGIS 2.18 (http://www.qgis.org/en/site/).

The final trigger for the landslide is unclear. Seismic waves from a M_W 4.1 earthquake about 500 km away arrived about 2 minutes before the failure, producing ground motion that would not be uncommon multiple times a year in this area[25], but might have contributed to the final failure. Similarly, 2015 rains at the nearest gage 110 km away in Yakutat were about 10% more than usual in Sept. and Oct (as-usual the rainiest months of the year). Such deviations above average are common in the years preceding the landslide, but elevated water tables may have contributed at least to the seasonal timing.

Landslide detection and extent

We first identified the 2015 landslide by seismic inversion, using the method of Ekstrom and Stark[26,27]. The seismic waves of the Taan Fiord landslide, equivalent to a M 4.9 earthquake, were observed globally. We used an automated landslide detector to identify the seismic signal within hours of the event, which included an abundance of 20 to 100 second period energy, as is typical of large landslides[25]. Long-period waveforms from the Alaska Regional Network were used to determine the forces associated with the landslide and to refine the estimated location to within 5 km. Seismic inversion suggested an eastward-moving (bearing 96°) landslide that generated peak forces of about 2×10^{11} N and lasting 90 seconds. The landslide source location inferred from seismology was near the calving front of Tyndall Glacier (Fig. 2). Based on earlier mapping of fjord geometry[18], the seismogenic motion of the landslide was assigned a length of 1.5 km. These findings, combined with the seismologically determined force history, further suggested a slide mass of $1–1.5 \times 10^{11}$ kg. Thus, the Taan Fiord landslide was one of the largest non-volcanic landslides in decades[26,28].

These initial estimates were revised within the next year by satellite and aerial imagery, lidar, and ground surveys. The landslide above the terminus of Tyndall Glacier unleashed 7.6×10^7 m^3, or 1.8×10^{11} kg of debris. The estimated volume and mass is based on the difference between 2012 and 2016 DEMs, and on an estimate of the slide material remaining in the slide scar. Extending the failure plane beneath onland deposits shows that about 33% of the evacuated volume is still onshore; the rest entered the fjord. Presuming that initial motion was downslope, the landslide moved in a direction similar to that inferred by seismic inversion. The majority of the slide followed the fjord bottom, curving right in an approximately 90° arc blanketing the fjord bottom to its limit 6 km from the source[28] (Fig. 2). Additional slide material travelled directly eastward through the fjord (Fig. 2) and up onto the far shore, depositing hummocks of semi-coherent slide material that blanket the fjord bottom and crest ~15 m above sea level[29]. This material likely traversed across the bottom of the 90 m-deep fjord and then traveled upwards 105 m to reach its final resting place.

If we assume that the hummocks represent the leading edge of the landslide, the slide velocity must have been at least 45 m s^{-1} (162 km h^{-1}) for the Taan landslide, similar to values reported for other rock avalanches of comparable dimensions (1903 Frank slide, Alberta, Canada: 3×10^7 m^3, 49 m s^{-1}; 1912 Mageik, Alaska: 5.4×10^7 m^3, 24 m s^{-1}; 1925 Gros Ventre slide, US-Wyoming: 3.8×10^7 m^3, 59 m s^{-1})[30]. This estimate is based on the simple conversion of kinetic to potential energy $v = (2gh)^{0.5}$ often used in landslide studies to estimate flow velocity from runup height (h)[31], assuming no potential energy transfers from the body of the slide to the leading edge. These assumptions can overstate maximum velocities in some cases[31], but also fail to account for friction or the transfer of momentum to water. Alternatively, the hummocks may represent a later phase of the landslide that travelled over earlier deposits that had partly filled in the fjord. In this case, the hummocks would have traversed water as shallow as 50 m, and the minimum flow velocity for the slide would be closer to 36 m s^{-1} (130 km h^{-1}).

Tsunami generation, propagation, and runup

When landslides enter water, the direct hazard they pose (e.g.[32,33]) can be extended by the resultant tsunami (e.g.[17,18,34]). In Taan Fiord the landslide directly affected about 2 km^2 of land onshore, while over 20 km^2 were inundated by the tsunami. We derive the initial tsunami geometry, constrained by landslide volume and aspect ratio, velocity, and duration[35]. Using a coupled set of solid and fluid mechanics models[35], we estimate that the measured landslide dimensions and material properties generated a leading wave near the head of the fjord with crest elevation of 100 m and period of 90 seconds. In the 100 m water depth near the source area, the front of this wave would have started to break at this crest height, approaching the sloping fan on the far side of the fjord as a plunging or surging breaker. To reach its peak elevation of 193 m (Figs 2, 4), the tsunami required enough initial kinetic and potential energy to not only climb the slope, but also overcome energy lost to turbulent dissipation and sediment interaction.

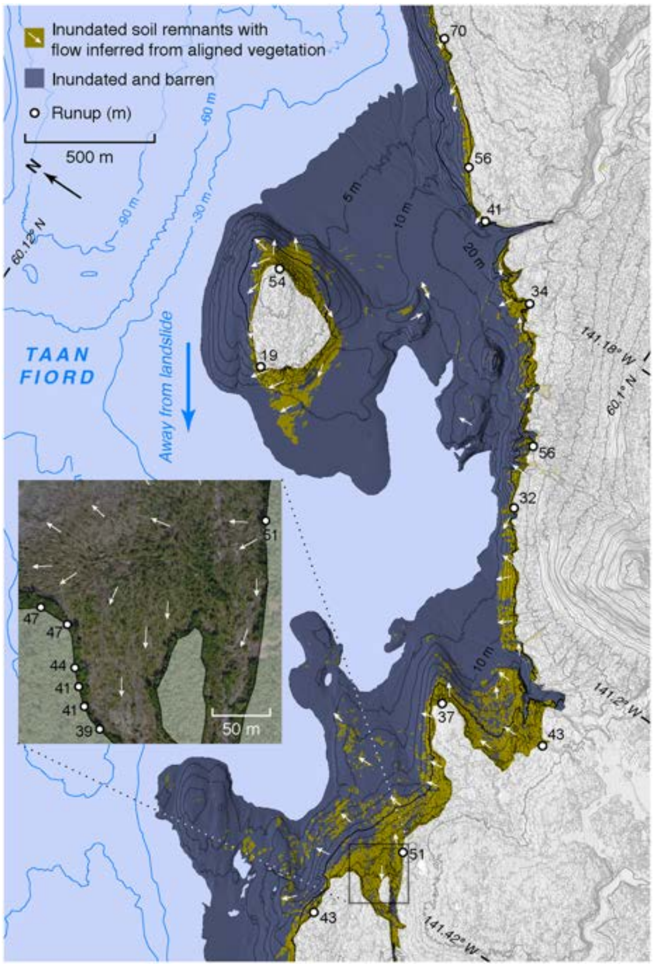

Figure 4. Tsunami recorded by its onshore traces. The Taan Fiord tsunami flooded over 20 km^2 and left water lines, soil remnants, and flattened, oriented trees. The inset orthorectified imagery includes an example of detailed runup and oriented tree mapping. Bathymetric contours from 28. Map created with QGIS 2.18 (http://www.qgis.org/en/site/).

The tsunami traveled south away from the landslide source area, down the fjord. Shallow water wave theory (aka long water wave theory[36]) computes a propagation speed of $(gh)^{0.5}$, or about 30 m s^{-1} in Taan Fjord's 100 m deep water. The tsunami proceeded to strip alder forest to elevations exceeding 50 m along the upper 7 km of the fjord, before encountering a range of hills (Fig. 2). These hills caused complex wave interference, expressed as runup elevations that rise and fall by tens of meters across distances of a few hundred meters (Fig. 4). Variability in the flow is further evidenced by uneven stripping of soil, and by the diverse orientations of still-rooted but flattened trees. Farther down the fjord, runup was diminished, reaching between 10 and 30 m elevation. Even with these relatively low runup elevations, the tsunami energy during overland flow was strong enough to leave only soil and debris where young forest with a 10 m canopy previously stood. The leading crest of the tsunami exited the fjord within 12 minutes, based on numerical modeling of the tsunami (see Methods). At distances greater than 5 km from the mouth of Taan Fiord, tsunami runup was below the high tide shoreline and no longer directly measureable during our first field survey six months after the event.

Geologic traces of the tsunami

The tsunami left thick distinctive deposits that were unlike those documented from other modern tsunamis[16] as it overran and resurfaced several alluvial fans along Taan Fiord (see Supplementary Fig.). On the hardest-hit fan (Hoof Hill Fan) the change in surface elevation between DEMs from before and after the event showed the deposit exceeded 5 m thick in places. Even at the most distal fan studied, where the tsunami runup had diminished to 16 m, the deposit was still 40 cm thick. These deposits included many fragments of supple wood, sometimes overlaid pre-tsunami soil, and occasionally included uphill flow-direction indicators. Deposits characterized from numerous recent tectonic tsunamis were typically sandy, less than 10 cm thick, and often normally graded[14]. Some of the Taan Fiord tsunami deposits were similarly normally graded as well, however in most ways they were very different. They included abundant coarse sediment ranging up to boulders, and are composed of three distinct units that we could find no analog for in the literature describing tsunami recent historic tsunami deposits.

The three units were most distinct where the tsunami was largest, at Hoof Hill Fan. The lower unit (A) is composed of sand to boulders, while the upper unit (B) is typically well-sorted and composed of cobbles or boulders. A third unit (C), composed of normally graded sand, was found where it infiltrated unit B.

Similar three-part deposits also partially blanketed fans farther down-fjord, although in many cases unit B was thin or absent, and in a few places the deposit was capped by complex layered sediment that we left uncategorized. Unit A might resemble debris flows from upland sources but can be distinguished by evidence of scour and of uphill flow found at the base. Unit B is similar to, but more tabular and widespread than, sieve deposits found on alluvial fans[37]. DEM differencing shows that these deposits are widespread and commonly meters thick at Hoof Hill Fan (Fig. 5), and thus likely to be preserved for millennia. Deposits in more sediment-poor settings are thin and patchy, but include transported boulders up to 5 m in diameter.

The difference between the deposits in Taan Fiord and those that have been recently described in other tsunamis might be due to differences in sediment source, depositional setting, or wave shape, among other things. The difference in deposit composition may simply reflect a difference in sediment source: In both Taan Fiord and tsunami deposits elsewhere, the bulk composition of the deposit is similar to the source sediment, whether that source is sandy beaches or bouldery alluvial fans. Also, a fan is importantly different from a coastal plain because the retreating wave may have the capacity to rework significant sediment as it runs down the sloping surface. In contrast, coastal plains drain more slowly, and typically sediment is only mobilized in localized constrictions during withdrawal[16]. Finally, while tectonic tsunamis have a long period, usually over 10 minutes, the period of the Taan Fiord tsunami was likely similar to the 90 seconds it took the slide to do most of its acceleration and deceleration. This difference in period likely had large impacts on temporal and spatial variability in the tsunami flow as it moved onland, and thus on the erosion and deposition of sediment.

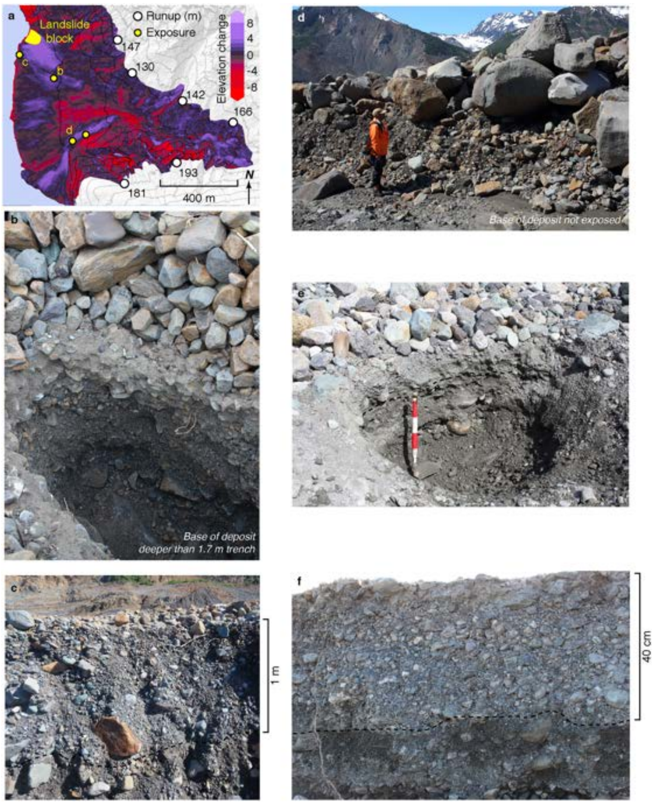

Figure 5. Taan Fiord tsunami deposits. The change in elevation between a 2014 DEM derived from satellite photogrammetry and 2016 lidar data reveals multi-meter changes in surface elevations of an alluvial fan reached by the landslide and swept by the tsunami (**a**). Where exposed in erosional banks or trenches, the deposit included a lower unit of very poorly sorted sand to boulders, and an upper unit of sorted boulders or cobbles (**b**,**c**,**d** - locations noted on map). At the trench in (**b**), and the outcrop in (**d**), the pre-tsunami surface was not exposed. However the outcrop in (**c**) extended down below the pre-tsunami surface, exposing siltier, browner sediment (contact dashed). Laterally, portions of the original soil was intact, and included shrubs folded uphill in the direction of tsunami inflood. Further down fjord, similar deposits were found where runup was about 50 m (**e**, contact dashed). Even where the tsunami had diminished to the point where runup was only 16 m, the deposit was still 40 cm thick and included abundant cobbles (**f**, contact dashed). Map in (**a**) created with QGIS 2.18 (http://www.qgis.org/en/site/).

The tsunami deposits in Taan Fiord may be particularly useful in identifying or interpreting deposits of similar events that produce short-period waves, and send those waves over sloping surfaces with diverse sediment available. For example, deposits interpreted to have been generated by landslide tsunamis have been documented in Hawaii[38] and the Canary Islands[39], pre-Quaternary deposits in the rock-record have been interpreted as records of large landslide or impact-generated tsunamis (summary in 14), and possible impact-generated tsunami traces have been described on Mars[40,41]. The deposits in Taan Fiord provide the first well-constrained example that might be used to interpret these and other ancient deposits, in order to better understand the frequency and magnitude of landslide and bolide impact tsunamis. If viewed independently, and out of geomorphic context, neither of the sedimentary units left by the Taan tsunami are necessarily indicative of a landslide-triggered, short-period tsunami. However, taken together and contextualized with the other evidence, the sedimentary deposits may prove sufficiently distinct to aid in the identification of paleo tsunamis. We provide more detailed descriptions of the tsunami sedimentology in the Supplementary Figure.

Implications for hazards assessment

The landslide and tsunami predicated by glacial retreat at Taan Fiord represents a hazard occasioned by climate change. More such landslides are likely to occur as mountain glaciers continue to shrink and alpine permafrost thaws. These landslides can more often be expected to produce tsunamis as water bodies grow and extend landward, closer to steep mountain slopes. Other notable landslides have occurred in recently deglaciated regions (e.g.[3,4,9]) and some have produced tsunamis (e.g.[17,19,34,42,43], Table 1). Their locations, though mostly remote, are attracting tourism and development. For example, incomplete failure and ongoing slow slip have been documented on a slope at Tidal Inlet, a fjord in Glacier Bay National Park, 6 km from a channel visited by dozens of cruise ships during summer months[24]. On 28 June, 2016, an approximately 1.5 × 10^{11} kg landslide collapsed onto Lamplugh Glacier, also in Glacier Bay National Park, but luckily did not reach tidewater and so did not trigger a tsunami[44,45]. Then on 17 June, 2017, a landslide in Rink Fiord triggered a tsunami that killed 4 people in Nuugaatsiaq, Greenland, 30 km away, highlighting the need for further study of these phenomena.

Comparison of pre- and post-event data at Taan Fiord constrain the dimensions of the landslide and tsunami, and in turn may aid in identifying other such events in the recent geologic past. In order to mitigate the risk associated with landslide-triggered tsunamis, we suggest the following: 1) revisit geologic records of paleotsunamis to better understand frequency and causal mechanisms of past occurrences; 2) assess areas of potential failure given known glacial histories and evidence of precursory motion; and in areas of particular concern, 3) map areas of likely impact using glacier, landslide, and tsunami inundation models in order to reduce impacts should an event occur; and finally 4) monitor for landslides using seismic and remote-sensing techniques.

Methods

Remote-sensed topography

For our landslide volume estimate, documentation of precursory motion, and mapping of deposit thickness (Fig. 5) we used a variety of Digital Elevation Model (DEM) and imagery sources. The earliest DEMs are taken from airborne interferometric synthetic aperture radar data (InSAR), while more recent DEMs come from satellite photogrammetry, as well as airborne lidar and structure-from-motion (SfM). The InSAR-based DEM's are taken from 2002 and 2012; these are freely available 5-m resolution models, and can be downloaded at http://maps.dggs.alaska.gov/elevationdata/#-16000000:9338001:4. We construct satellite DEMs, including the 2014 DEM referenced in Fig. 5, from high-resolution along-track stereo optical satellite imagery using SETSM[46] on the University of North Carolina Chapel Hills' Killdevil HPC system. The resulting DEMs have a resolution of 2 m. The optical DEMs are co-registered to the 2012 InSAR DEMs by masking out all water and snow and ice from the InSAR DEMs, leaving only bedrock, converting the InSAR bedrock into a pointcloud then applying an iterative closest point matching routine to minimize the RMS difference between the optical DEM and the InSAR DEM. DEMs used in this study are available from both the Polar Geospatial Center at the University of Minnessota, and similar DEMs of the area, registered to satellite altimetry using different methods than this study are available from the ArcticDEM project (Arcticdem.org).

During 2016 fieldwork we collected lidar and imagery for SfM over Taan fjord and parts of Icy bay. The lidar was collected using methodology from[47], and SfM topography and orthoimagery was produced using methodology in[48].

DEM differencing shows that 5.8 × 10^7 m^3 of landslide material is missing - providing a minimum volume on the landslide.

By extrapolating the failure plain beneath slide material still onshore, we expand this estimate to 7.6 × 10^7 m^3. To estimate the mass represented by this volume, we used a density of 2350 kg/m^3. Most of the landslide material is a weakly lithified sandstone. Sandstones have density values between 2150 and 2650 kg/m^3 [49]. The value of 2350 kg/m^3 is based on rocks from the Susitna and Cook Inlet basins, Alaska, which have a similar composition, age, and burial history (e.g.[50,51]).

To understand precursory motion, we compared successive DEMs, and also reviewed imagery provided through Google Timelapse[44], which presents Landsat imagery that is clear enough for identifying landslide scarps and grabens back to 1995.

Runup survey

We used a variety of instruments to perform the ground-based tsunami runup survey. The instruments that were used to survey the tsunami markers included a laser rangefinder, a total station, and two differential Real Time Kinematic (RTK) GPS systems. A combination of these instruments was commonly used for a single measurement point, as the terrain was difficult and flow markers were at times inaccessible. There were four different general approaches for surveying data points in this survey. The first approach was used for markers located on steep mountain slopes, where run-up was clear, but not easily accessible, and required shooting from a distance. For such points, the RTK-GPS system was used in combination with the rangefinder to obtain a spatial location. A second approach was employed in situations where the ample forestry or tree tops obstructed the RTK-GPS signal. In this scenario, a combination of the total station and the RTK-GPS system was used to obtain the necessary coordinate points with high accuracy. Thirdly, for flow markers of large elevation (e.g. more than 10 meters) and/or large inundation distance (e.g. many 100 s of meters) that were also entirely accessible due to relatively easy terrain and lack of dense canopy, the RTK-GPS system was used on its own. Finally, for flow markers of relatively low elevation and inundation distance, the rangefinder on its own was used in locations where it was not practical to setup the RTK base and rover system. In the paragraphs below, we briefly describe each of the measurement devices, and their expected precision.

The RTK-GPS system was used to in order to achieve highest possible accuracy. Survey monuments were created throughout Taan Fiord, and their coordinates were determined via static GPS measurements. Many monuments were established to accommodate the radius of radio coverage of the RTK-GPS system. The expected errors are +/−1 cm for the horizontal, +/−3 cm for the vertical measurement using RTK-GPS. In addition to instrument error, some human error must be taken into account. The human error is estimated to be +/−5 cm in holding the pole upright and on stable ground. Thus the RTK-GPS systems are expected to have measurement errors bounded by 10 cm.

When using the total station, the instrument location was determined by acquiring its relative location to four well-distributed points with known coordinates. Following the setup of the total station, a surveyor used a reflector to collect the tsunami markers. The errors for a typical distance of ~200–300 m are +/−1.5 mm for the distance, +/−0.001° for the inclination, and +/−0.001° for the bearing. The human error was again determined to be +/−5 cm in holding the pole upright and on stable ground.

When used in conjunction with a RTK system or the total station, the rangefinder location was determined from the RTK rover, and the distance/vertical angle/bearing measurements from the rangefinder provided the coordinates of the tsunami marker. The errors for a typical distance of ~50–10 0 m are +/−30 cm for the distance, +/−0.25° for the inclination, +/−1° for the bearing. The human error in holding the rangefinder vertically and steady was determined to be +/−10 cm.

As discussed above, the expected errors of each measurement are strongly dependent on the equipment used as well as the local terrain, but are likely less than 10 cm for measurements not using the rangefinder, and less than 30 cm for measurements using the rangefinder. In addition, the tsunami marker elevations need to be presented as relative to the tidal level at the time of the tsunami. Of course, there are no direct measurements of the sea level in Icy Bay during the tsunami. Based on sea level data measurement during the field campaigns, we find that the tides within Icy Bay match those at the NOAA tide station in Yakutat, to within 14 cm at high and low tide, with a mean RMS error of 3 cm. Therefore, the error associated with referencing the runup measurements to the sea level at the time of the tsunami is on the same order or smaller than the error in the runup measurements themselves.

Tsunami source model

To approximate the landslide motion and initial generation of the tsunami, we use the 3D Simplified Arbitrary Lagrangian Eulerian model (iSALE) in the area within 3 km of the slide. The slide geometry and motion are constrained by observations of the failure area, and the force time-history of the slide. We use the tsunami generated by iSALE to specify the initial condition in the weakly dispersive, nonlinear Cornell University Long and Intermediate Wave Model (COULWAVE). COULWAVE simulates the tsunami evolution through Taan Fiord and Icy Bay, including relevant dissipation from wave breaking and bottom friction (results not presented in this paper). Ref.[30] contains technical details on both of these models, as well as details of the coupling.

Tsunami Deposits

To characterize the Taan tsunami deposits, we documented outcrops and trenches across several alluvial fan-deltas. Outcrops were opportunistic, while most trenches were chosen to be in areas of relatively little variation in the surface of the deposit. Trenching and documenting was extended down to the upper part of pre-tsunami sediment wherever possible. Each was described, photographed, and sampled, with particular attention being paid to grain-size variability and contacts within the tsunami deposit. We provide descriptions of the outcrops in the Supplemental Figure.

Tsunami deposits were easily distinguished from underlying pre-tsunami alluvial fan-delta deposits. We documented tsunami deposits within 9 months of the tsunami, and fragmented wood that had been living at the time of the event remained supple and green where it was trapped in the deposit. These provided clear markers for tsunami deposits. In some cases, pre-tsunami soil, roots, and rooted vegetation highlighted the base of tsunami deposits, though often the soil was scoured away, and the decades-old soil was typically faint.

Marine Geophysical Surveys

During Summer 2016, we acquired multibeam bathymetry data from the R/V *Alaskan Gyre* and from a remotely operated surface vehicle the *Jokull* for all of Taan Fiord. Also, multichannel 2D seismic data were acquired from the *Alaskan Gyre*. These data are discussed explicitly in 28 and 29 and are only used here to provide a general description of the submarine part of the landslide.

Data availability

Grain size distribution data available upon request to hig314@gmail.com.

Additional information

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ΑΦΙΕΡΩΜΑ ΣΤΑ ΦΡΑΓΜΑΤΑ

ΑΣΦΑΛΕΙΑ ΦΡΑΓΜΑΤΩΝ

Dam Safety: Room for Improvement

Russell W. Ray

While dams provide tremendous benefits ranging from flood control to power generation, they also represent a risk to public safety. Some of North America's leading dam safety experts sat down with Hydro Review to discuss efforts to improve dam safety.

The 2005 breach of Taum Sauk reservoir, a man-made lake that feeds a pumped storage hydro plant in eastern Missouri, and other recent dam failures have led the dam safety community to take a hard look at dam safety programs and the techniques being used to identify deficiencies that could lead to a failure.

Of the more than 80,000 dams in the U.S., about a third pose a "high" or "significant" hazard to life and property if a failure occurs, according to the Federal Emergency Management Agency (FEMA).

Hydro Review magazine Senior Associate Editor Russell W. Ray moderated a roundtable discussion involving some of North America's leading dam safety experts. The discussion centered on new inspection and monitoring methods, the state of financing for dam repairs, the cost of better inspection methods, and the effects on service and product suppliers.

The participants were: Brian Becker, chief of the Bureau of Reclamation's Dam Safety Program; Charles Pearre, dam safety program manager, U.S. Army Corps of Engineers; Dan Mahoney, director of the Federal Energy Regulatory Commission's Division of Dam Safety and Inspections; Constantine "Gus" Tjoumas, technology coordinator for Dam Safety, CEATI International; Paul C. Rizzo, president of Paul C. Rizzo Associates Inc.; and Warren Witt, manager of hydro operations, AmerenUE.

What follows is a transcript of that discussion.

Q. How is the dam safety community improving the efficiency and effectiveness of dam safety programs in North America?

Paul: The dam safety community has made a giant leap in its efficiency and effectiveness, with the implementation of Potential Failure Mode Analysis (PFMA), developed originally by the Federal Energy Regulatory Commission (FERC). The program has allowed a large number of people to understand the importance of dam safety, including operators, engineers and managers. It's been a tremendous help in doing dam inspections, dam safety analysis and so forth. I'll go so far as to say that if we had done a PFMA at Taum Sauk in 2003 or 2004, the Taum Sauk failure might have been prevented.

Gus: To echo what Paul is saying, with tools like the PFMAs, we're learning to be more proactive than reactive and understanding what that means. With respect to dam safety, you just don't look at one little piece of the dam. You look at how the dam operates overall, with all of its components. We haven't always done a very good job of that before. We zeroed in on specific things. Now, we understand that we have to look at dam safety on an overall project basis and not just the embankment, the powerhouse or the spillway.

Dan: It's really only been recently - the last couple of years - that the dam safety industry has made the connection between the importance of a good owner's dam safety program and preventing dam failures. All it took was a review of the historical dam failures. Just about every one in recent history had an element of a breakdown in a dam safety program. We really haven't gotten the word out to state dam safety regulators about how much an effective dam safety program can reduce the risk of dam safety incidents.

Brian: I think the dam safety community is doing a better job of communicating by sharing information and common best practices and working together to develop more training opportunities. There's a lot of training available. There's really been an emphasis among dam safety owners to implement and develop emergency action plans. There certainly is a lot of interest in risk management. There's a lot of training and collaboration.

Warren: I'm not a dam safety specialist for our company. I operate and maintain three hydropower plants. So I'm a user of dam safety programs. To me, there appears to be a lot more emphasis being placed on dam safety and a lot more coordination among dam safety entities. As a user, that helps our ability to implement these and to understand what the expectations are. With the increased communications, we all have a better understanding of what the expectations are.

Charles: Five years ago, the Corps moved into more of a risk-informed technology to work our dam safety program. We have completed a portfolio risk analysis and initial screening of all our 650 dams and are developing a set of tools that can be used by different dam owners to review the risks their dams have and the possibilities of failures. The Corps, the Bureau of Reclamation and the Federal Energy Regulatory Commission have been working together to develop these tools and also to improve the Potential Failure Mode Analysis methods. I think all these are bringing us to a point where we are identifying where the greatest risks are.

Q. How do these changes affect service and product suppliers?

Brian: There is enormous potential for service providers to develop expertise in Potential Failure Mode Analysis and risk assessment. I think there is significant demand in the industry to support that.

Paul: All of the dam safety programs of significant quality have increased surveillance and monitoring equipment and services. That part of the industry has definitely increased and improved as a consequence of the upswing in dam safety programs and the results of PFMAs.

Gus: As potential failure modes are identified at each dam, understanding has improved on what needs to be monitored and what needs to be instrumented. Perhaps there are instruments that are no longer necessary. Then again, it might lead to the design of new types of instruments. Hopefully, they'll come up with improvements to instruments that are available to measure the things we need to measure. As examples, zones of seepage and piping are always difficult to ascertain.

Warren: If you are a service or product supplier, you will have more certainty in what will be accepted. That will allow you as a supplier to go out to other customers and say this has been an accepted process.

Charles: We've been able to put more money on some dam safety fixes. We realized that there's a maximum capability of the construction contractors and the equipment they own in order to do foundation fixes. We're keeping them busy.

Q. What new tools are available for diagnosing dam behavior and preventing problems?

Dan: The Potential Failure Mode Analysis is a big step forward in diagnosing dam behaviors and preventing problems.

Charles: A number of the things that we're finding today are problems that occurred during design and construction 40 and 50 years ago. We're able to take more instrumentation readings. There's automation of the instrumentation where you can get readings automatically and set programs up to tell you if a trend is occurring. This is especially useful for owners of multiple dams.

Warren: Automation allows you to do real-time, continuous monitoring instead of spot monitoring.

Q. What are the expected financial and staffing implications of the applications for these new tools and methods?

Dan: I think the PFMA can have a beneficial impact on financial and staffing implications because of what the PFMA does. In general, there are 100 ways dams can fail. But for a specific dam, a lot of those ways can be ruled out. That's what the PFMA does. It looks at the specific dam and it really determines how this particular dam can fail. It can make the monitoring program more efficient and less costly. It also could reveal a potential failure mode that you didn't realize, which would require additional resources and additional monitoring.

Brian: I think there are significant financial and staffing implications. I think we're right on the crest of the wave of moving forward with PFMA and risk management in the dam safety community. The potential extends beyond dam safety to any other infrastructure. It behooves anybody to develop a good understanding of PFMA and risk management.

Paul: Before the PFMA protocol became a requirement of the FERC and other nonregulated dam owners, the traditional dam inspection had moved toward becoming a commodity. Who could do it the cheapest and on the fastest schedule? It wound up being something that would be done by a junior engineer at the lowest cost. Inserting the PFMA into the process returned it back to its original intent: A thorough inspection thoroughly thought out by experienced people. Cost became less of a factor, although it became a more expensive process in the end.

Gus: Someone said earlier that it's going to cost more in the beginning, but in succeeding years, it's going to be less. Well, it could be, and in certain cases, it may not be. That still hasn't been borne out. Certainly the cost and efforts required for those dams identified to have potential problems identified through new tools and advanced methods will increase, but these costs will undoubtedly be less than costs associated with a dam failure.

Warren: It takes financing and staffing to implement these tools and methods. But once implemented, because you've automated some things, your staffing may be able to decrease or certainly not increase because you've got computers helping you do some of what you used to do manually. I haven't talked to many end users that have actually been able to reduce staff because of this. I think most people are still in the stage of increased engineering and expenditures, trying to put a lot of this stuff in.

Charles: It's been very hard to maintain a growing operations and maintenance budget that meets the requirements of inflation. Therefore, we have been looking at reducing staff and automation and instrumentation are ways we are looking at to do this. It does cost a little bit to put it in. In the end, you get the information from the instruments much easier, quicker and the computers are helping you analyze the data. Therefore, the cost of analyzing the data goes down. However, with instrumentation and automation, you've put something on the structure and it's subject to vandalism and wear and tear. So you're going to have maintenance that you might not have had in the past. Your financial costs are probably going to be about the same.

Q. How are risk assessment methods being applied at dams in North America?

Brian: We do risk assessments at all levels, at the very rudimentary screening level and at the comprehensive facility review level. As we're taking a more detailed look, we perform another risk assessment to ensure the decisions we are making are the right decisions. We're using them significantly and at various levels. We do risk assessments to verify that proposed modifications are going to satisfy the intent. Even after we've modified a project, we continue to perform risk assessments on a periodic basis.

Paul: I think risk assessments, at least in North America, are moving more and more toward probabilistic approaches to risk assessment. In the earlier days, we began looking at probabilistic hydrology issues. Nowadays, our seismic hazards are determined by probabilistic seismic hazard analyses. One of these days, we may put all of this together in some sort of logic tree and come up with probabilistic failure of the dam by overtopping, by seismic, by liquefaction and a number of other different factors.

Brian: I think that's one of the intents. To be able to compare, as Paul was saying, those specific failure modes relative to one another on a rational basis. You're putting the potential of seepage failure on the same relative scale as you would a seismic failure or a hydrologic failure.

Gus: There is much more work ahead of us with respect to the probabilistic approach. We need better data and information to do a better job at that. There is still data to be collected and case histories to be reviewed to help in this. That's why it is so important to have a good database of case histories. The Bureau of Reclamation is using risk assessments and analyses for a good risk-informed decision making process. But it's not done alone. We still do our deterministic approaches. We still do our traditional analyses. It's another tool we use to make a better risk-informed decision.

Dan: I think that's an important point to make. In the short time that risk assessment has been used in the U.S., it has gone from risk assessment answers to risk-informed decision making. The risk assessment is used as another piece of information along side the deterministic analyses that the industry has traditionally done.

Warren: It really helps in prioritizing. There's only so much expertise and contractors available out there. So you've really got to prioritize. It's helping the industry prioritize what are the most risk-significant dams and dam problems and putting your efforts toward those first.

Charles: We've been able to use risk assessment methods to level the playing field for our dams so that we are getting to the most critical ones first. It's a national priority and it's getting us additional budgeting priority from Congress. We are able to tell them what risks we are reducing. When you can define the risk and explain what the risk is, they become more willing to provide funding for you.

Q. What are the chief causes of dam failures in North America?

Paul: Overtopping.

Brian: Overtopping, seepage.

Dan: Statistically, I thought it was seepage.

Brian: I think overtopping is the highest.

Gus: I think overtopping is the high and seepage and piping is probably second.

Paul: Overtopping is something that's avoidable. You can perform the necessary calculations and develop a "fix" to prevent it.

Gus: Overtopping might occur because the spillway was inoperable. That's the type of thing that causes dams to overtop in general, other than extreme floods.

Warren: The chief causes are more programmatic in that whatever technically caused it, it probably had something to do with a lack of maintenance or lack of an oversight program. Some of that gets back into funding.

Charles: I agree that lack of maintenance has been one of the main causes of failures. Most of the failures on privately owned and publicly owned dams have been due to foundation problems. Lack of maintenance and lack of continual monitoring to catch things at an early stage allowed things to proceed to the point that the dam failed.

Warren: We had a dam failure a few years ago, a big dam, Taum Sauk reservoir. One of my concerns in looking at the root causes and the responses to that was that a lot of dam safety experts are really focused on the civil engineering aspects of how to build or maintain the dam. A lot of our oversight really focuses on the civil engineering, technical aspect. I think our dam safety programs need to look much more programmatic at what programs do you have in place to train your staff. What finances do they have available? Do they have adequate staff to do their jobs? Do they have a formal formatted surveillance monitoring program?

Q. Can you describe the state of financing for maintenance, upgrade and repair at non-federal dams?

Dan: Of the 75,000 dams that are privately owned, there is a lack of resources. Right now, the law is that the dam owner has to pay to fix it, and the dam owners, a lot of times, don't have the financing.

Gus: Several states do not have funds available for this. New Jersey has a low-interest loan program. As an example, I think there is even some grant money given out under certain circumstances.

Warren: Because we had a dam failure in the not too distant past, our state of financing has been extremely good. We have done a lot of work, a lot of maintenance, a lot of upgrade at our hydro facilities. As we come to the end of doing those upgrades and things become more standard, our financing will get a little more difficult to maintain because there will be other things that become more critical and we'll have to fight to keep our financing and manpower resources available.

Charles: I'd say the state is terrible. The locals do not seem to be willing to put the funds into repairing the dams. Only when they get to near failure do they start looking for funding. For the most part, most of them do not have the funds to fix the dam.

Q. The National Dam Safety and Security Act was passed in 2002. The measure was designed to help states improve their dam safety programs, increase training for dam safety engineers, and boost funding for dam safety research. How would you assess the law's impact on dam safety thus far in the U.S.?

Brian: It seems like the act has had a positive effect to improve dam safety programs and to increase and provide training opportunities. I think a potential shortfall is related to the governance of the National Dam Safety Review Board. Could it be reconsidered, where would it be most effective and more appropriate to lead that organization from, and how that program can be more effective. I think the National Dam Safety and Security Act was well intended and successful. But I think with a good introspective review and some strategic thinking, that group can become more effective.

Dan: I would add, though, that with respect to the resources that the state dam safety programs need to really have adequate programs, the funds that the National Dam Safety program is providing doesn't come close to filling the gap. There is some improvement. There's increased training and a lot of coordination and collaboration, but the resource deficit is still very much there.

Paul: I think Brian is being too polite. I think the program was well intended, but I don't see much in the way of benefits. There's just not enough money.

Gus: There's been some help to the states, especially those that have little money. It has been a benefit to the states with respect to being able to get out and do a few more inspections. The big thing is the training aspect that it provides to state dam safety engineers.

Charles: The Corps is a member of the National Dam Safety Review Board. This program has provided the states more money and I believe they are moving forward on increasing their training and boosting the amount of money that's going into dam safety research. Only in the last two years has the Federal Emergency Management Agency been able to get an increase in the amount of funding to the states. I think it is starting to help and it will help in the future.

Russell Ray is senior associate editor of Hydro Review

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ΕΠΙΣΚΕΥΗ - ΕΝΙΣΧΥΣΗ ΦΡΑΓΜΑΤΩΝ

Dams and Civil Structures: Geomembrane Installed to Control Leakage at Gem Lake Dam

John C. Stoessel and John A. Wilkes

To address continuing leakage at its Gem Lake Dam, Southern California Edison commissioned installation of a geomembrane on the upstream surface. Results indicate seepage through the dam has been reduced by as much as 90 percent since the geomembrane liner was installed three years ago.

Like many other dam owners, Southern California Edison (SCE) is faced with aging infrastructure that has experienced decades of harsh environmental conditions. SCE owns and operates 37 dams with an average age of 80 years. Concrete deterioration, seepage, and degradation of facing materials are just a few of the issues that need to be addressed to maintain safe operation of dams. SCE has a comprehensive plan and schedule for critical dam rehabilitation that will allow these structures to continue to be valuable resources well into the new century.

One aspect of that plan is the installation of geomembrane liners on the upstream faces of four of SCE's concrete dams and all four of SCE's wood-faced dams. In 2006, SCE completed placement of the first geomembrane liner on Sabrina Lake Dam, a wood-faced rockfill dam on the Middle Fork of Bishop Creek.[1] The liner reduced seepage through the dam by 90 percent.

In the summer of 2007, Gem Lake Dam became the second SCE dam fitted with a geomembrane liner. This was needed to address freeze-thaw conditions that had led to concrete deterioration and subsequent seepage.

Structural deficiencies and complicating circumstances

SCE's 13-MW Rush Creek Power Project is on Rush Creek in Mono County, on the eastern slope of the Sierra Nevada mountains. The project consists of three dams (including Gem Lake Dam), three storage reservoirs, and one two-unit powerhouse.

Gem Lake Dam is a multiple arch concrete dam that impounds a reservoir with a capacity of 17,288 acre-feet. The dam is located in the Ansel Adams Wilderness Area. Gem Lake Dam is one of the first examples of multi-arch concrete dam design in the U.S. The dam is composed of 16 complete arches, each of 40-foot span between the centers of the buttresses. In addition, a partial arch at each end of the dam ties into the rock abutments. The dam is 688 feet long, with a maximum arch height of about 84 feet. The arches are 1 foot thick at the top and 3.95 feet thick at the bottom and are reinforced with concrete gravity sections up to elevation 9,027.5 feet. The buttresses range in thickness from 1.85 feet at the top to 4.25 feet at the lowest point. The buttresses are braced by counterforts ranging in width from 4.5 feet at the top (15 feet below the crest of the dam) to 11 feet at the lowest point. Double 12-inch by 18-inch concrete struts are placed between the buttresses.

The dam was built in 1915 and 1916 using aggregate found in the streambed of Rush Creek and adjacent rock. Because of the construction techniques of the time and the design of the concrete mix, the concrete is somewhat porous, which allows water to fill voids in the structure. In the winter, this water freezes, causing expansion and spalling of the concrete surface. Water migrating through the dam causes deterioration of the cement/aggregate matrix as cementitous material is leeched out, leaving pockets of loose aggregate. In several places, the concrete to a depth of 1 foot or more can be removed using a geologist's hand pick.

In 1966, a program was undertaken to cover the entire upstream face with about 3 inches of gunite reinforced with heavy steel wire mesh. The gunite was sealed with polysulfide, placed in two coats over a primer. In 1969, a third coat of polysulfide was placed on the upstream face. The polysulfide coatings initially were successful in preventing water migration. However, their long-term performance proved less than desirable, as the coatings peeled away from the dam, leaving the gunite exposed.

Table 1: Costs of the Three Rehabilitation Alternatives

	Projected Price	Life Expectancy	Yearly Amortization of Cost, at 4% Annual Inflation
Shotcrete upstream face	$2,750,000	20 years	$202,345
Polysulfide coating	$2,500,000	20 years	$183,950
Geomembrane liner	$2,750,000	50 years	$128,000

In 2006, SCE conducted an extensive site investigation to quantify the extent of concrete deterioration. Dean White, a concrete consultant, observed the concrete condition, obtained corings, and took Schmidt hammer measurements. The conclusion of this investigation was that decades of uninterrupted freeze-thaw cycles had left substantial pockets of degraded concrete in two of the arches. Any attempt to repair those areas would be fruitless until the seepage through the dam was stopped.

Seepage through Gem Lake Dam, completed in 1916, was severe and resulted in significant damage to the dam face.

Determining how to repair the dam

SCE identified and investigated three alternatives for dealing with the leakage at Gem Lake Dam:

– Remove the degraded polysulfide coating and replace with like in kind;

– Apply another gunite layer to the upstream face; and

– Apply a geomembrane liner over the upstream face.

With regard to the first two alternatives, removing the peeling polysulfide would require a method for collecting and disposing of the debris. In addition, the polysulfide coating already demonstrated a relatively short life-span (about 20 years). SCE had applied a layer of reinforced gunite in 1966 and, while it did significantly reduce seepage through the dam (by more than 50 percent), large cracks developed after about 20 years, allowing water to reach the original concrete and initiating the freeze-thaw cycles once again.

Geomembranes have been installed on more than 85 dams worldwide, constituting an area of more than 6.2 million square feet of dam face and a service life exceeding 850 years. Given this performance record, a life expectancy of more than 40 years was easily justified.

Damage to the upstream face of Gem Lake Dam as a result of continuing seepage consisted of large cracks in the gunite and deteriorated polysulfide coating.

While the three alternatives had similar initial costs, they varied significantly in the estimated amortized annual costs (see Table 1). In addition, the geomembrane liner had a longer projected life (in excess of 40 years, compared with 20 years for coatings or gunite) and fewer environmental issues related to installation.

Design of the rehabilitation

The dam's location in a designated wilderness area provided some challenges. The primary means of transportation is a combination of two cabled tramways and a boat. Permits were required from several agencies, including the U.S. Forest Service (USFS), U.S. Fish and Wildlife (FWS), U.S. Army Corps of Engineers, and Regional Water Board. Activities in the wilderness require primitive methods to be used unless a compelling case can be made for mechanization. SCE showed that the liner could only be installed in a single season through the use of a mechanical excavator and four-wheeled vehicle. The effect on the wilderness environment, in the form of a drained reservoir, that would be incurred by extending the work to two seasons was greater than the effect of using mechanical equipment.

SCE negotiated a design and construction contract with CARPI USA in 2008. The contract included terms for ACE Restoration Company to perform grouting on the two arches suffering from significant damage. Before installing the geomembrane, CARPI provided a detailed design of the system, plans, and specifications. This included a constructability review with USFS and a pre-construction meeting of representatives from SCE, CARPI, ACE Restoration, and USFS to ensure all components of the installation were properly planned.

The design and execution of the Gem Lake Dam geomembrane system was complicated because of:

– Logistics involved with accessing the dam;

– Complicated geometry of the dam structure;

– Short window for construction due to high altitude; and

– Environmental constraints of working within a wilderness area.

The unique geometry of Gem Lake Dam required new design features and installation techniques to cost-effectively access the front face of the dam. On previous similar installations, CARPI's installation crew accessed the front face of the dam using scaffolding. For Gem Lake Dam, the cost to transport the scaffolding up the mountain and assemble it would be prohibitive (estimates were in excess of $200,000). In fact, if scaffolding was used it is unlikely the installation could have been completed in one season, a major goal of the installation.

In 2006, CARPI installed a geomembrane liner on Linach Dam in Germany. For this installation, CARPI personnel used swing stages to access the upstream face of the dam. A swing stage is a two-point adjustable suspension scaffold that is hung by ropes or cables connected to stirrups at each end of the platform. Swing stages typically are used by window washers but also are used in the construction industry. Although there would still be small areas of Gem Lake Dam that required scaffolding, the swing stages would allow access to more than 90 percent of the surface.

Because of their reduced transportation costs, use of the swing stage platforms would allow a significant reduction in potential costs to the project.

During this design phase, a careful preliminary design and analysis of the structure led to the conclusion that the typical method of installing tensioning profiles would not work at the intersection of adjacent arches. The geometry of the arches at Gem Lake Dam (relatively short arch spans) created an area at that intersection that was simply too tight. CARPI developed a new multi-layer system design and then constructed a full-size mockup, documenting each stage of the installation. This provided assurance to SCE and the California Department of Safety of Dams (DSOD) that the installation could be completed successfully.

Installing the geomembrane

Work to install the geomembrane liner at Gem Lake Dam began in June 2007 and involved many steps. In rough spots (about 3 percent of the surface), CARPI installed a 2,000-gram-per-square-meter geotextile directly on the surface to smooth irregularities and thus decrease surface preparation costs. Next, over the entire face, CARPI installed a Tenax Tendrain geonet (triplanar) for a drainage layer, with a thin geotextile to contain the existing polysulfide coating. CARPI then installed submersible watertight perimeter (stainless steel) seals along the foundation, crest of the two spillway arches, and both abutments. A non-submersible watertight perimeter (stainless steel) seal was installed along the crest of the 16 non-spillway arches. At three locations, CARPI installed drainage plates, with a drilled hole through the face at each location to allow discharge of water through the dam body. Stainless steel batten strips then were installed at the spring of the arches vertically, and stainless steel tensioning profiles were installed on the center of each arch vertically to hold the geomembrane to the dam.

A key design element of the geomembrane liner at Gem Lake Dam was a new attachment system in the spring of the arches (see arrow). This spring area was so tight that tensioning profiles at previous dams could not be used here.

The geocomposite, which consists of a polyvinylchloride (PVC) geomembrane 3 millimeters thick with 500 grams per square meter of geotextile, was installed in 1.05-meter widths horizontally on the face of each arch. Finally, CARPI personnel installed 3-millimeter-thick PVC geomembrane welding strips to cover the stainless steel tensioning profiles.

The key element of this system is the PVC geocomposite that waterproofs the entire face of the dam. This geocomposite consists of a geomembrane heat-coupled during extrusion to a non-woven geotextile. The geocomposite is attached to the face vertical profiles. This anchorage technique enables the geocomposite to elongate over large areas, minimizing stress to the material. The anchorage system also allows a drainage layer to be attached to the face of the dam because there is no adhesive layer to clog the drainage layer. This liner anchorage allows for two key benefits:

– Provides the possibility of drainage and subsequent discharge by gravity of seepage water that infiltrates the waterproofing liner or dam body. The water is collected and discharged downstream by a pipe installed through the dam; and

– Allows tensioning of the geomembrane to prevent the formation of wrinkles and sagging that can reduce the longevity of the installation.

Benefits from dam rehabilitation

Many benefits were achieved from installation of the CARPI geomembrane system at Gem Lake Dam:

The final area covered by the geomembrane system at Gem Lake Dam was more than 60,800 square feet over 16 complete arches and two partial arches with two arches grouted. All of this work was completed in 15 weeks.

– Seepage control. Seepage measurements taken since the geomembrane installation was completed in September 2007 show reductions of 50 percent to 90 percent and no visible seepage in the unbuttressed sections (upper 30 feet of arches).

– Eliminating freeze-thaw deterioration. Stopping the passage of water through the dam will dry the downstream face, eliminating the cause of freeze-thaw deterioration.

– Longevity. The CARPI system has a successful track record on more than 85 dams. Dam rehabilitation installations have been in operation for more than 30 years. It is expected that these installations will exceed 50 years, as documented in a geomembrane sampling study from six existing projects.2

– Cost effectiveness. The geomembrane system and the other options had effectively the same installation price.

However, with the proven longevity of the geomembrane system, the life-cycle cost analysis shows the

CARPI geomembrane to clearly be the most cost-effective. The geomembrane system had minimal environmental effects, while both shotcrete and polysulfide would have required significantly more environmental safeguards. Lastly, the volume and weight of materials required for the shotcrete option made it unattractive because of the additional cost of tram transport and likely maintenance issues from heavy use. The polysulfide and geomembrane system had similar transportation costs. However, the geomembrane system was significantly safer. Almost all the geomembrane system materials were solids so that if a load was lost during transit, there was no significant hazard. The polysulfide system involved liquids and paste that would have represented a significant clean-up risk in the event of an accident.

– Fewer environmental effects. The geomembrane system had significantly fewer project environmental effects than the other options. The geotextile on the geonet drainage layer enabled the existing polysulfide coating to be captured in place without any need to remove. Both the shotcrete and polysulfide options would have required this layer to be removed, which would have been expensive and difficult. The geomembrane installation at Gem Lake Dam was completed without any construction or alteration of the site. No sediment was released, as the reservoir shoreline was more than 100 feet upstream of the dam face. Minimum instream releases were maintained throughout the installation process.

– Greater aesthetic value. The geomembrane installation at Gem Lake Dam will remain mostly underwater more than 90 percent of the time, leaving the dam appearance essentially unaltered. When the geomembrane is exposed, either during low water years or drained reservoir conditions, the geomembrane is a neutral gray color that gives the dam a clean, uniform appearance that blends well with the surrounding terrain.

– Minimal maintenance. The CARPI geomembrane system is a passive system that requires no maintenance.

Future installations

SCE is investigating the benefits of installing similar geomembrane liners on several other dams, including Agnew Lake (concrete multi-arch), Hillside and Saddlebag (wood-faced rockfill), Shaver Lake (concrete gravity), and Tioga Lake (wood-faced rockfill main dam and concrete arch auxiliary dam).

John Stoessel, P.E., a senior engineer with Southern California Edison's Dam Safety Group, was project manager for the *geomembrane installation work. John Wilkes, P.E., is president of CARPI USA, the company that manufactured and installed the geomembrane liner.*

Notes

1. Tech Briefs, Hydro Review, Volume 26, No. 4, August 2007.

2. Cazzuffi, D., "Long Term Performance of Exposed Geomembranes on Dams in Italian Alps," International Conference on Geosynthetics Conference Proceedings, Industrial Fabrics Association International, Roseville, Minn., 1998.

(Hydro Review, Vol. 29, Issue 5, July 2010, http://www.hydroworld.com/articles/hr/print/volume-29/issue-5/articles/dams-and-civil-structures.html)

ΑΣΤΟΧΙΕΣ ΦΡΑΓΜΑΤΩΝ

An Examination of Dam Failures vs. Age of Dams

Patrick J. Regan

Some dam failures stem from long-term use, while other incidents are tied to earthquakes, floods, and other events. How are failures distributed over the life of a dam? And does a long period of satisfactory performance mean there will be no significant incident over the remainder of its life?

Dam safety professionals must be ever vigilant in their efforts to assure the safety of dams and other water retention or control structures under their charge; whether owner, regulator or consultant, none can be complacent when it comes to dam safety.

And yet, all too often complacency creeps in when a dam has had a lengthy history of apparent successful operation. How many times have we heard, or used the words, "The dam's been OK for 50 years. Why are you worried about it now?"

During many Potential Failure Mode Analysis sessions conducted by the Federal Energy Regulatory Commission, this reasoning came up as a way to lower the categorization of a potential failure mode.

We seem to forget that dams are subject to many of the affects of aging and exposure that we are all subject to. Some failures are the result of long-term use. In humans, it may result in carpal tunnel syndrome; in dams, it may result in the failure of a gate hoist mechanism.

Some incidents are simply due to a longer exposure to a potentially hazardous situation.

Diseases like cancer may come on rapidly or progress over a long period of time. Similarly, piping can be a rapidly developing situation on first filling like at Teton Dam or a longer process such as at Kantale Dam in Sri Lanka that failed from piping after 117 years of, apparently, successful operation.

This article attempts to address four questions:

1. How are dam incidents distributed over the life of a dam and in particular, does a significant period of apparently satisfactory performance indicate that a dam will have no significant incidents over the remainder of its life?

2. Is there a difference in long-term performance among the different types of dams?

3. Are there particular potential failure modes that contribute significantly to safety incidents over time?

4. Is there a difference in the types of delayed incidents depending on the year the dam was constructed?

To address the questions stated above, the author developed a database of dam failures and safety related incidents that at the present time includes over 4000 individual dam failures and incidents from 84 countries. The age of the dam when the failure or incident occurred could be determined for 1158 of these incidents.

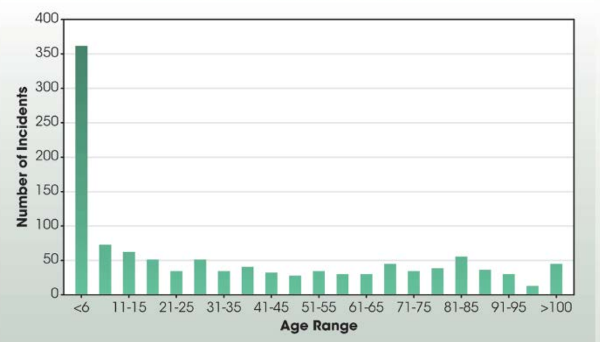
Question 1

How are dam incidents distributed over the life of a dam and, in particular, does a significant period of apparently satisfactory performance indicate that a dam will have no significant incidents over the remainder of its life?

It is generally assumed that the initial years of a dam's life are the most dangerous and the data bears out this assumption.

About 31 percent of the dam safety incidents analyzed for this paper occurred during construction or the first five years of a dam's life (see Figure 1). Among dam types, there was a statistically significant variation in certain types of dams with 18 percent of gravity dams and 29 percent of arch dams experiencing incidents within the first five years, while 42 percent of both earthen dams and rockfill dams suffered incidents during construction or within the first five years.

FIGURE 1 Number of Dam Incidents vs. Age For All Dam Types Combined



The high percentage of dam safety incidents occurring within the first five years of operation points out the importance of thoroughly examining a potential dam site, making sure that the dam's design accounts for site-specific conditions that could result in the initiation and development of a potential failure mode, constructing the dam carefully in order to minimize the potential for a failure mode to initiate, and implementing a focused surveillance and monitoring program to examine how the dam is behaving.

The second half of the first question was examined by considering only the data for those dams where the incident occurred after five years of operation.

The data for dams that suffered a safety incident after the first five years of operation was plotted as an exceednce graph that shows the percentage of reported dam incidents that occurred beyond a given age. According to a database of dam failures and safety-related incidents developed by the author of this paper, 49 percent of all dam incidents occurred at age 50 or beyond as shown in Figure 2. The available data does not show a major difference in the number of incidents that occurred in any five-year period.

The two five-year periods with the highest number of incidents after the first five years of operation were six to ten years of age with 72 incidents and 11 to 15 years of age with 61 incidents. However, the third highest was 81 to 85 years of age with 55 incidents.

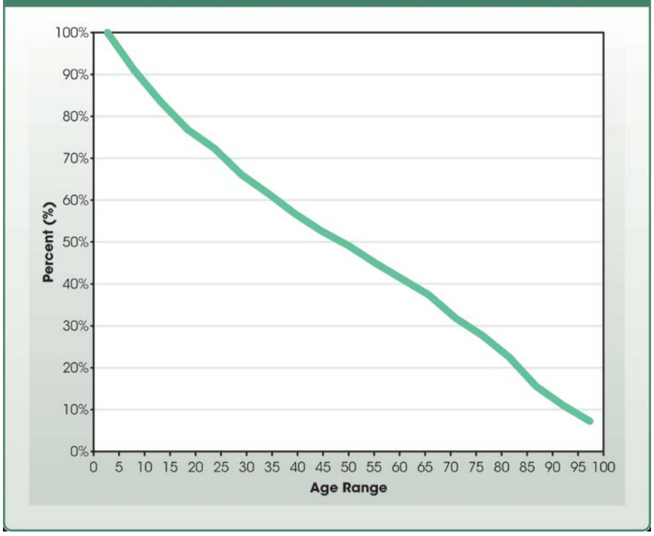
Certainly the number of dams that suffer a failure or serious incident is a relatively small percentage of the total dams constructed. However, data indicates that a significant percentage of dams that suffer a delayed safety related incident do so at age 50 or beyond.

Therefore, we should not be less vigilant as a dam ages nor be surprised if a dam safety incident develops as a dam ages. In fact, some failure modes may become more likely with age.

The average date of construction of dams in the incident database used for this paper, where the age at the time of incident could be determined, is 1933, 77 years ago.

However, this average date of construction is skewed by a few very old dams, the oldest being constructed in 1550, while 451 (39 percent) of the dams were constructed after 1945 and are therefore, at most, about 60 years old.

FIGURE 2 Incidents Rates of Dams That Survive Their First Five Years



Question 2

Is there a difference in long-term performance among different types of dams?

When the data for incidents that occurred after the first five years of operation for each type of dam is plotted as an exceedance graph, the graph shows some distinct variations in the longer-term performance of dams (see Figure 3).

Earthfill dams have a higher than average failure rate during the first 50 years of operation with only 31 percent of incidents occurring at age 50 or beyond, as compared to nearly 50 percent for all types of dams combined. In contrast, gravity dams exhibit better than average performance for the first 70 years of operation compared to all types of dams. Rockfill and arch dams have somewhat worse performance than average over the initial years of operation but, in general, trend closer to the average than either earthfill or gravity dams.

The difference in performance between earthfill and gravity dams may be partially explained when the failure modes for each type are examined. The principal failure modes for earthfill dams are: Internal erosion/seepage/piping, 110 incidents; overtopping, 105 incidents; and structural issues, 47 incidents.

Gravity dam incidents include 101 related to flood loadings, often related to spillways, and 115 related to structural issues, including concrete deterioration and the structural performance of appurtenant structures such as spillway gates and gate operators. Also, there are 27 incidents of piping in the foundations of gravity dams. Of the 115 structural issues, 41 were related to spillway gates.

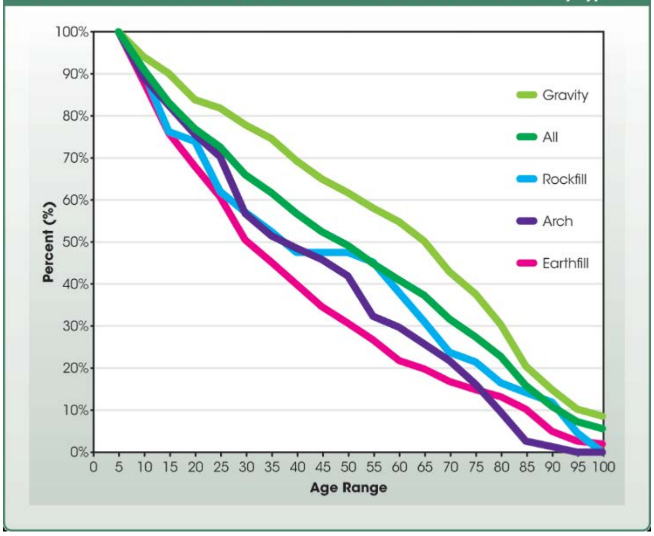
Seepage is a potential failure mode that is always active, assuming the water level is at least as high as the critical pathway, and it may also be exacerbated by the higher water levels during floods or a favored pathway may be opened due to seismic induced cracking.

Therefore, internal erosion and piping are potential failure modes that must always be considered for all embankment dams and in the foundations of all dams. On the other hand flood loadings, especially extreme floods, are relatively rare events and the probability of occurrence during early years of a dam's operation is relatively small. Similarly, degradation processes are time dependent and actions such as ASR or freeze-thaw may negatively impact the structure only after an extended period of time.

Degradation is also a significant component in incidents related to electrical/ mechanical equipment. Degradation of electrical/mechanical equipment may be due to simple wear and tear from use or a lack of preventative maintenance.

The shape of the curves in Figure 3 may also be influenced by the large numbers of dams that were built in the last 40 to 50 years.

FIGURE 3 Incidents Rates of Dams That Survive Their First Five Years By Type



Question 3

Are there particular failure modes that contribute significantly to safety incidents over time?

In order to answer this question, the data was sorted by age at the time of the incident and the failure modes grouped into three categories; flood related, structural, and seepage/piping.

Failure modes related to reservoir slides, other reservoir events and other failure modes not related to these three categories made up insignificant percentages of the identified incidents and were dropped from the data. All failure modes related to flooding whether caused by an extreme flood, spillway plugging, failure of a gate to operate when needed, etc., were placed in the flooding group. Structural events included incidents such as sliding, embankment slope instability, earthquake damage, concrete degradation, and gate failures. Seepage/piping included all internal erosion, piping and seepage related failure including those through the embankment, through the foundation, and those into or along outlet works. The data was analyzed for all incidents in the database and for those where the dam had survived the first five years of operation.

Only 65 percent of all seepage incidents occur after five years of operation, whereas 74 percent of flood-related incidents and 78 percent of structural incidents occur after the first five years. It is interesting to note that after 80 years of operation, all three failure modes have nearly the same percentage of incidents that will occur in future years.

Data indicates that after the first five years of operation, there is some difference in the percentage of failures occurring among the different failure modes with structural related failures occurring at a lower rate. However, after 45 years of operation, there is little distinction to be made in the percentage of incidents yet to occur from either flood, seepage or structural failure modes.

At the extreme end of the data, dams that experience a failure or incident after 100 years of operation, there were 45 incidents where both the age and failure mode were identified.

Of the 45 incidents, 22 were related to flooding, 13 to structural issues, and ten to seepage.

This information indicates that, although seismic and flood loadings are generally considered remote events and failures related to overtopping or damage from earthquakes can be easily rationalized as remote incidents from extreme events, we cannot forget about piping and other seepage related incidents when dealing with embankment dams and in the foundations of all dams.

Seepage related incidents are the most common modes of failure in the early years of a dam's life and continue to be an important potential failure mode over the longterm.

Question 4

Is there a difference in the types of delayed incidents depending on the year the dam was constructed?

The average construction year of dams in the database, where the age at the time of the incident could be determined, is 1933. This is prior to the development of current theories of rock mechanics, filters and drains and the application of modern geotechnical engineering theory into the design on many dams. The incident database shows peaks in number of incidents in certain construction eras due in part to the number of dams of a particular type built in the particular era.

The smaller number of incidents in the later years may be due to better design but may also be due to a smaller number of dams being constructed since the building boom of the 1960s and 1970s, or the shorter period of time that these later dams have been exposed to processes that take time to develop.

We examined the relationship between seepage related incidents in earthfill dams in greater detail by plotting the percent of seepage/piping incidents that occurred beyond a given age by the era in which the dam was constructed. The dams were grouped by those constructed before 1900, those constructed from 1900 to 1950, and those constructed between 1950 and 1975. The data includes 65 incidents for both the 1900-1950 group and the 1950-1975 group and 26 dams in the pre-1900 group.

To account for the difference in exposure between newer and older dams, the data for incidents that occurred in the first five years of operation and those that occurred beyond 45 years of operation was removed to provide a picture of how dams have fared in the five to 45 years of age range.

The data indicates that there is no real difference in the percentage of incidents that occur at advanced ages for earth dams constructed between 1900 and 1950 and those constructed after 1950. Dams constructed before 1900 actually show that once past the initial five years of operation the percentage of incidents that occur at later ages is greater than for newer dams, especially in the five to ten years of age range. After ten years of operation the older dams continue to have a greater percentage of the total incidents occurring at a later age than either of the more recent groups.

Pat Regan, PE, is regional engineer for the Division of Dam Safety and Inspection, Federal Energy Regulatory Commission, Portland, Oregon.

This article has been evaluated and edited in accordance with reviews conducted by two or more professionals who have relevant expertise. These peer reviewers judge manuscripts for technical accuracy, usefulness, and overall importance within the hydroelectric industry.

(Hydro Review, Vol. 29, Issue 4, June 2010, http://www.hydroworld.com/articles/hr/print/volume-29/issue-4/articles/dams--civil-structures.html)

ΔΙΑΚΡΙΣΕΙΣ ΕΛΛΗΝΩΝ ΓΕΩΕΠΙΣΤΗΜΟΝΩΝ

International Association for Engineering Geology and the Environment

Ο Βασίλης Μαρίνος Αντιπρόεδρος της Διεθνούς Ένωσης Τεχνικής Γεωλογίας

Στα πλαίσια του Παγκοσμίου Συνεδρίου της Διεθνούς Ένωσης Τεχνικής Γεωλογίας (International Association of Engineering Geology and the Environment), που διεξήχθη προσφάτως στο San Francisco / USA (17-21 Σεπτεμβρίου), έγιναν εκλογές για την συγκρότηση της νέας Εκτελεστικής Επιτροπής για την περίοδο 2019-2022. Ο Βασίλης Μαρίνος, Αναπληρωτής Καθηγητής στο Τμήμα Γεωλογίας του Αριστοτελείου Πανεπιστημίου Θεσσαλονίκης, εξελέγη Αντιπρόεδρος μετά από ψηφοφορία 53 χωρών.

ΝΕΑ ΑΠΟ ΤΙΣ ΕΛΛΗΝΙΚΕΣ ΚΑΙ ΔΙΕΘΝΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΝΩΣΕΙΣ

UNIVERSITY OF CAMBRIDGE
Department of Engineering

Seminar

Seismic Design of Onshore and Offshore Pipelines: A Challenging Topic of Geotechnical And Structural Engineering

Dr. Prodromos Psarropoulos
Senior Teaching and Research Associate,
School of Rural & Surveying Engineering,
National Technical University of Athens (NTUA), Greece

Many onshore and offshore pipeline projects are expected to be constructed during the next decades for the smooth transmission of oil, gas, water, or even sewage. Depending on the circumstances and the local site conditions, any pipeline has to be verified against all potential hazards and the consequent loading. One of the main categories of loading that may cause substantial pipeline distress (and damage) is the permanent ground displacements caused by the potential earthquakerelated geohazards. The main emphasis of this presentation is on the seismic design of pipelines which actually includes: (a) the quantitative assessment of all earthquake-related geohazards, (b) the realistic estimation of the seismic pipeline distress, and (c) the design of the potential mitigation measures.

Biography

Dr. Psarropoulos is a Structural and Geotechnical Engineer who obtained his Ph.D. on Geotechnical Earthquake Engineering from NTUA. He then became an adjunct Associate Professor of Geophysics and Earthquake Engineering in the Department of Infrastructure Engineering of the Hellenic Air-Force Academy. He has published more than 20 papers in refereed journals and more than 150 papers in conference proceedings, while currently he is teaching under-graduate and post-graduate courses of "Soil Mechanics & Foundations", "Geotechnical Engineering" and "Design of Offshore Structures" at NTUA. In parallel, during the last 20 years, he has been involved (as a consultant) in the design and construction of many challenging engineering projects in Greece, Albania, Italy, and India.

When and where:
Wednesday, 17 Oct, 19:00
Bowett Room, Queens' College

Queries: Charalampos Konstantinou, ck494@cam.ac.uk

ΠΡΟΣΕΧΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΚΔΗΛΩΣΕΙΣ

Για τις παλαιότερες καταχωρήσεις περισσότερες πληροφορί-ες μπορούν να αναζητηθούν στα προηγούμενα τεύχη του «πε-ριοδικού» και στις παρατιθέμενες ιστοσελίδες.

1st International Conference TMM_CH Transdisciplinary Multispectral Modelling and Cooperation for the Preservation of Cultural Heritage, 10-13 October, Athens, Greece, www.tmm-ch2018.com

HYDRO 2018 - Progress through Partnerships, 15-17 October 2018, Gdansk, Poland, www.hydropower-dams.com/hydro-2018.php?c_id=88

GEC - Global Engineering Congress Turning Knowledge into Action, 22 - 26 October 2018, London, United Kingdom, www.ice.org.uk/events/global-engineering-congress

ISEV 2018 CHANGSHA The 8th International Symposium on Environmental Vibration and Transportation Geodynamics & the 2nd Young Transportation Geotechnics Engineers Meeting, October 26–28, 2018, Changsha, China, www.isev2018.cn

8th International Congress on Environmental Geotechnics "Towards a Sustainable Geoenvironment", 28 October to 01 November 2018, Hangzhou, China, www.iceg2018.org

ARMS10 - 10th Asian Rock Mechanics Symposium, ISRM Regional Symposium, 29 October - 3 November 2018, Singapore, www.arms10.org

UNSAT Oran 2018 4ème Colloque International Sols Non Saturés & Construction Durable, 30-31 October 2018, Oran, Algeria, www.unsat-dz.org

Energy and Geotechnics The First Vietnam Symposium on Advances in Offshore Engineering, 1-3 November 2018, Hanoi, Vietnam, https://vsoe2018.sciencesconf.org

ACUUS 2018 16th World Conference of Associated Research Centers for the Urban Underground Space "Integrated Underground Solutions for Compact Metropolitan Cities", 5 – 7 November 2018, Hong Kong, China, www.acuus2018.hk

ISRBT2018 International Seminar on Roads, Bridges and Tunnels - Challenges and Innovation, 9-15 November 2018, Thessaloniki, Greece, http://isrbt.civil.auth.gr

International Symposium Rock Slope Stability 2018, 13-15 November, 2018, Chambéty, France, www.c2rop.fr/symposium-rss-2018

☙ ❧

https://www.piarc.org/ressources/documents/INTERNATIONALS-SEMINARS-PROCEEDINGS/International-Seminar-TC-D4-Tunis-Tunisia-November-2018/29086,International-Seminar-First-Announcement-TC-D4-Rural-Roads-and-earthworks-Tunisia-November-2018-World-Road-Association-PIARC.pdf

In order to promote the exchange of experiences and the transfer of information and technology on low-traffic rural roads and to facilitate technical discussions and debates among stakeholders of the sector, Technical Committee D.4 Rural Roads and Earthworks of the World Road Association (PIARC) is organizing an **International Seminar on "The Best Practices for Earthworks and Rural Roads**". This event is co-organized by the Tunisian Road Association (ATR) and the Tunisian Ministry of Equipment, Housing and spacial Planning (MEHAT).

The seminar is open to the road community interested in low-traffic rural roads and to all stakeholders from countries with similar geographical, climatic and socio-economic needs.

The following topics will be covered (non-exhaustive list):

- Experiences and management of earthworks in the region and future challenges
- Best practices for planners and professionals in the development and sustainability of rural access through the use of alternative materials
- Planning and other local pre-requisites including the involvement of local communities
- Earthworks and bare roads

PIARC Technical Committee D.4 Rural Roads and Earthworks brings together members from different countries of the world, their knowledge and experiences are shared and disseminated through publications, the participation and organization of international seminars and the exchange of practices in different countries and regions of the world.

The official languages of the seminar are English and French with simultaneous translation.

Details of contact with the organizers

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3rd South American Symposium on Rock Excavations
November 19-20-21, Santiago, Chile
www.sasore.com

The Chilean Society of Rock Mechanics (SCMR, the Chilean Group of the ISRM) is proud to announce the organization of the **3rd South American Symposium on Rock Excavations** (SASORE 2018), to be held in Santiago, Chile on November 19, 20, 21 of 2018 under the theme of "**Learning from the past, thinking in the future**". This symposium encompasses all aspects of rock mechanics, rock engineering, and geomechanics related to excavations in civil and mining engineering.

- Field characterization.
- Analysis and design.
- Construction and operation of rock excavations.
- Other subjects.

The following topics are going to be dicussed in SASORE 2018:

- Field Characterization
- Analysis and design of rock excavations
- Construction and operation of rock excavations
- Design strategies for excavations
- Slope stability
- Design and stability of underground excavations
- Rock mass properties and characterization

In the framework of the 3rd South American Symposium on Rock Excavations, SASORE 2018, it has been considered relevant to foster a comprehensive discussion regarding the current knowledge and practice about the acceptability criteria for rock excavations. The proposed workshop covers the visions of six renowned specialists in the world of rock mechanics, which leads to expecting that it will become a relevant contribution in the matter.

Contact us: info@sasore.com

GeoMEast 2018 International Congress and Exhibition: Sustainable Civil Infrastructures, 24 - 28 November 2018, Cairo, Egypt, www.geomeast.org

AR AUSROCK The Fourth Australasian Ground Control in Mining Conference, 28–30 November 2018, Sydney, Australia, http://ausrock.ausimm.com

Second JTC1 Workshop on Triggering and Propagation of Rapid Flow-Like Landslides, 03-05 December 2018, Hong Kong, Email: ceclarence@ust.hk

13th Australia New Zealand Conference on Geomechanics 2019, 01 ÷ 03-04-2019, Perth, Australia, http://geomechanics2019.com.au

AFRICA 2019 Water Storage and Hydropower Development for Africa, 2-4 April 2019, Windhoek, Namibia, www.hydropower-dams.com/pdfs/africa19.pdf

OMIŠ 2018
8th Conference of Croatian Geotechnical Society with international participation
Geotechnical challenges in karst
Karl Terzaghi and karst in Croatia 110 years ago
11.-13. April 2019, Omiš, Split, Croatia
www.hgd-cgs.hr/savjetovanja/omis-2019

As karst poses many challenges to engineers, karst is the main subject of this conference. However, we will receive papers with other topics in geology, geotechnical engineering etc.

It is worth knowing that great Karl Terzaghi started his rich career in Croatian karst, in Gacko polje, just 110 years ago. His first contributions to geology and geotechnical engineering will be remembered in a special lecture, to inspire us all. Hence the subtitle of the conference

The topic of the congress has arisen from a whole range of new life requirements. Let's just mention some. By spreading the settlements at the bottom of the high cliffs, there is a need for a high-quality protection against the rockfalls. The need to build garages in urban areas, and to save valuable resources on the surface for other purposes, the coastal towns descend underground into the area of the karst. The construction of the foundations of large bridges and viaducts in the coastal zone creates a challenge in the transfer of concentrated loads into karst characterized by a number of weaknesses (karst sinkholes, caverns, …). The need for the construction of high speed roads in the coastal zone of the Republic of Croatia implicates excavations of long tunnels, which again is threat in the karst area.

If you are having some suggestions, questions, comments, please, write to omis2019.hgd@gradst.hr

IICTG 2019 2nd International Intelligent Construction Technologies Group Conference “Innovate for Growth, Collaborate for Win-Win”, 23-04-2019 - 25-04-2019, Beijing, China, www.iictg.org/2019-conference

WTC2019 Tunnels and Underground Cities: Engineering and Innovation meet Archaeology, Architecture and Art and ITA - AITES General Assembly and World Tunnel Congress, 3-9 May 2019, Naples, Italy, www.wtc2019.com

2019 Rock Dynamics Summit in Okinawa, 7-11 May 2019, Okinawa, Japan, www.2019rds.org

4th Joint International Symposium on Deformation Monitoring (JISDM), 15 to 17 May, 2019, Athens, Greece, www.jisdm2019.survey.ntua.gr.

Underground Construction Prague 2019, June 3–5, 2019, Prague, Czech Republic, www.ucprague.com

VII ICEGE ROMA 2019 - International Conference on Earthquake Geotechnical Engineering, 17 - 20 June 2019, Rome, Italy, www.7icege.com

ICONHIC2019 - 2nd International Conference on Natural Hazards and Infrastructure, 23-26 June 2019, Chania, Crete Island, Greece, https://iconhic.com/2019/conference

IS-GLASGOW 2019 - 7th International Symposium on Deformation Characteristics of Geomaterials, 26 - 28 June 2019, Glasgow, Scotland, UK, https://is-glasgow2019.org.uk

cmn 2019 -Congress on Numerical Methods in Engineering, July 1 - 3, 2019, Guimarães, Portugal, www.cmn2019.pt

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

2019 SECED

SECED 2019 Conference
Earthquake risk and engineering towards a resilient world

9-10 September 2019, Greenwich, London, U.K.
www.seced.org.uk/2019

The Society for Earthquake and Civil Engineering Dynamics (SECED) is organising a two-day conference to take place on 9-10th September 2019 in Greenwich, London. This is the first major conference to be held in the UK on earthquake engineering and risk since the SECED 2015 Conference. The conference will bring together experts from a broad range of disciplines, including structural engineering, nuclear engineering, seismology, geology, geotechnical engineering, urban development, social sciences, business and insurance; all focused on risk, mitigation and recovery.

The conference will take place in the modern facilities of the Greenwich University Architecture Building, with the conference dinner held in the Painted Hall of the Old Royal Naval College. We have 8 confirmed Keynote Lecturers from UK and international academic institutions and companies, and a number of conference oral and poster sessions, as detailed at: https://www.seced.org.uk/index.php/seced-2019.

Kind regards

Stavroula Kontoe

Conference Sessions

- Blast, impact and vibration
- Catastrophe risk modelling for earthquakes
- Design for nuclear safety
- Earthquake disaster risk reduction, reconnaissance and recovery
- Earthquake fragility and vulnerability
- Earthquake-triggered hazards and their impact
- Geotechnical earthquake engineering
- Induced seismicity
- Infrastructure system resilience
- Risk assessment in developing countries
- Seismic assessment and retrofitting
- Seismic design and analysis
- Seismic hazard and engineering seismology
- Seismic protective devices
- Soil-structure interaction
- Vibration serviceability

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

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

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

4º 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

The South African Institution of Civil Engineering cordially invites all our colleagues from Africa and beyond to attend the 17th African Regional Conference on Soil Mechanics and Geotechnical Engineering.

Hosted in one of the continent's most iconic cities, this conference will serve practitioners, academics and students of all geotechnical backgrounds. The conference will take place at the Cape Town International Convention Centre (CTICC) offering world class conferencing facilities in the heart of South Africa's mother city and will offer extensive opportunities for Technical Committee Meetings, Workshops, Seminars, Exhibitions and Sponsorships. Exciting Technical Visits, including tours to the famous Robben Island, await.

The 7th African Young Geotechnical Engineers' Conference (8 – 10 October 2019) will commence on 8 October 2019, the day following the African Regional Conference (ARC) opening. The conference venue will be shared with the ARC delegates to initiate dialogue between junior and senior engineers while young geotechnical engineers acquaint themselves with the industry standards, new geotechnical developments and resources available to further their careers. The YGE conference provides an approachable audience within a vibrant environment where young presenters under the age of 35 are encouraged to exercise their presentation and technical writing skills on a continental platform.

Organiser: SAICE
Contact person: Dr Denis Kalumba
Email: denis.kalumba@uct.ac.za

XVI Asian Regional Conference on Soil Mechanics and Geotechnical Engineering, 21 - 25 October 2019, Taipei, China www.16arc.org

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

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

14th Baltic Sea Geotechnical Conference 2020
25 ÷ 27 May 2020, Helsinki, Finland

Organiser: Finnish Geotechnical Society
Contact person: Leena Korkiala-Tanttu
Email: leena.korkiala-tanttu@aalto.fi
Website: http://www.ril.fi/en/events/bsgc-2020.html
Email: ville.raassakka@ril.fi

Nordic Geotechnical Meeting
27-29 May 2020, Helsinki, Finland

Contact person: Prof. Leena Korkiala-Tanttu
Address: SGY-Finnish Geotechnical Society,
Phone: +358-(0)50 312 4775
Email: leena.korkiala-tanttu@aalto.fi

EUROCK 2020
Hard Rock Excavation and Support
June 2020, Trondheim, Norway

Contact Person: Henki Ødegaard, henki.oedegaard@multiconsult.no

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
Phone: +44(0) 1223 332780
Email: me254@cam.ac.uk

16th IACMAG TORINO 2020 grenoble · milano

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.

Contact Information

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Phone: +390119211467
Email: info@symposium.it, marco.barla@polito.it

☙ ❧

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

We are pleased to invite you to the 7th EuroGeo conference, to be held in Warsaw, Poland in 2020. Poland is a country with more than a thousand years of recorded history and has a strong European identity. The country was first to free itself from communist domination in 1989 and is now fully democratic and a member of the European Union. Poland is a leader in infrastructure development in the region, which has resulted in many extraordinary projects. Warsaw, with its central location, is an ideal base for exploring the country. Today, the city is a dynamic cultural and business centre, with strong links not only to Western Europe but also to the East. PSG-IGS, a Polish Chapter of IGS is young but thriving organization successfully cooperating with several chapters within Central Europe. It is an honour to host such a prestigious conference in Warsaw and we sincerely believe that the sessions will prove to be a success. Come to Warsaw, bring your family and enjoy your stay in our capital and help us to make this Conference not only scientifically profitable but also an unforgettable event.

Proposed Sessions

- Agricultural Applications
- Coastal Protection
- Direct and Life-Cycle Cost Savings
- Drainage and Filtration
- Durability
- Embankments on Soft Soils
- Environmental Benefits
- Geosynthetics as Formwork
- Hydraulic Applications
- Innovations and New Developments
- Landfills
- Lightweight Construction
- Mining
- Monitoring
- Pavements
- Physical and Numerical Models
- Polymeric and Clay Geosynthetic Barriers
- Properties and Testing
- Quality Control and Quality Assurance
- Reinforced Walls and Slopes
- Roads, Railroads and Other Transportation Applications
- Seismic Applications
- Sustainability
- Unpaved Roads
- Wastewater and Fresh Water Storage

Contact: eurogeo7inpoland@gmail.com

☙ ❧

6th International Conference on Geotechnical and Geophysical Site Characterization
07-09-2020 ÷ 11-09-2020, Budapest, Hungary
www.isc6-budapest.com

Organizer: Hungarian Geotechnical Society
Contact person: Tamas Huszak
Address: Muegyetem rkp. 3.
Phone: 0036303239406
Email: huszak@mail.bme.hu
Website: http://www.isc6-budapest.com
Email: info@isc6-budapest.com

☙ ❧

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

☙ ❧

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

ΕΝΔΙΑΦΕΡΟΝΤΑ ΓΕΩΤΕΧΝΙΚΑ ΝΕΑ

Εντυπωσιακές φωτογραφίες κατολισθήσεων λόγω του σεισμού των 6.7 Richter στο νησί Χοκάιντο στην Ιαπωνία

Τουλάχιστον οκτώ άνθρωποι έχασαν τη ζωή τους εξαιτίας του σεισμού 6,7 βαθμών της κλίμακας Ρίχτερ, ο οποίος έπληξε τα ξημερώματα της Πέμπτης τη νήσο Χοκάιντο της Ιαπωνίας, ενώ δεκάδες άλλοι συνεχίζουν να αγνοούνται… Τα θύματα αυτά βρέθηκαν στα συντρίμμια ενός σπιτιού στο ορεινό χωριό Ατσούμα, όπου η ισχυρή σεισμική δόνηση προκάλεσε τεράστιες κατολισθήσεις, ορισμένες από τις οποίες καταπλάκωσαν σπίτια… Μια σειρά μετασεισμικών δονήσεων -η ισχυρότερη ήταν 5,4 βαθμών- ακολούθησε τον κύριο σεισμό… Η ιαπωνική μετεωρολογική υπηρεσία και προειδοποίησε τους κατοίκους ότι ίσως σημειωθούν ισχυροί μετασεισμοί τις προσεχείς ημέρες.

(http://www.kathimerini.gr/983330/gallery/epikairothta/kosmos/iapwnia-oktw-nekroi-dekades-agnooymenoi-meta-ton-seismo-twn-67-va8mwn-sto-nhsi-xokainto)

(http://www.kathimerini.gr/983460/gallery/epikairothta/kosmos/iapwnia-maxh-me-ton-xrono-gia-thn-aneyresh-epizwntwn-meta-ton-seismo---stoys-9-oi-nekroi)

(https://www.bbc.co.uk/news/world-asia-45429673)

(http://www.in.gr/2018/09/06/plus/photo-gallery/eikones-katastrofis-apo-ton-seismo-ton-67-rixter-stin-iaponia)

Mystery of the cargo ships that sink when their cargo suddenly liquefies

Susan Gourvenec
Professor of Offshore Geotechnical Engineering, University

Think of a dangerous cargo and toxic waste or explosives might come to mind. But granular cargoes such as crushed ore and mineral sands are responsible for the loss of numerous ships every year. On average, ten “solid bulk cargo” carriers have been lost at sea each year for the last decade.

Solid bulk cargoes – defined as granular materials loaded directly into a ship’s hold – can suddenly turn from a solid state into a liquid state, a process known as liquefaction. And this can be disastrous for any ship carrying them – and their crew.

In 2015, the 56,000-tonne bulk carrier Bulk Jupiter rapidly sunk around 300km south-west of Vietnam, with only one of its 19 crew surviving. This prompted warnings from the International Maritime Organisation about the possible liquefaction of the relatively new solid bulk cargo bauxite (an aluminium ore).

A lot is known about the physics of the liquefaction of granular materials from geotechnical and earthquake engineering.

The vigorous shaking of the earth causes pressure in the ground water to increase to such a level that the soil "liquefies". Yet despite our understanding of this phenomenon, and the guidelines in place to prevent it occurring, it is still causing ships to sink and taking their crew with them.

Solid bulk cargoes

Solid bulk cargoes are typically "two-phase" materials as they contain water between the solid particles. When the particles can touch, the friction between them makes the material act like a solid (even though there is liquid present). But when the water pressure rises, these inter-particle forces reduce and the strength of the material decreases. When the friction is reduced to zero, the material acts like a liquid (even though the solid particles are still present).

A solid bulk cargo that is apparently stable on the quayside can liquefy because pressures in the water between the particles build up as it is loaded onto the ship. This is especially likely if, as is common practice, the cargo is loaded with a conveyor belt from the quayside into the hold, which can involve a fall of significant height. The vibration and motion of the ship from the engine and the sea during the voyage can also increase the water pressure and lead to liquefaction of the cargo.

When a solid bulk cargo liquefies, it can shift or slosh inside a ship's hold, making the vessel less stable. A liquefied cargo can shift completely to one side of the hold. If it regains its strength and reverts to a solid state, the cargo will remain in the shifted position, causing the ship to permanently tilt or "list" in the water. The cargo can then liquefy again and shift further, increasing the angle of list.

At some point, the angle of list becomes so great that water enters the hull through the hatch covers, or the vessel is no longer stable enough to recover from the rolling motion caused by the waves. Water can also move from within the cargo to its surface as a result of liquefaction and subsequent sloshing of this free water can further impact the vessel's stability. Unless the sloshing can be stopped, the ship is in danger of sinking.

A cargo ship being loaded with bauxite.

The International Maritime Organisation have codes governing how much moisture is allowed in solid bulk cargo in order to prevent liquefaction. So why does it still happen?

The technical answer is that the existing guidance on stowing and shipping solid bulk cargoes is too simplistic. Liquefaction potential depends not just on how much moisture is in a bulk cargo but also other material characteristics, such as the particle size distribution, the ratio of the volume of solid particles to water and the relative density of the cargo, as well as the method of loading and the motions of the vessel during the voyage.

The production and transport of new materials, such as bauxite, and increased processing of traditional ores before they are transported, means more cargo is being carried whose material behaviour is not well understood. This increases the risk of cargo liquefaction.

Commercial agendas also play a role. For example, pressure to load vessels quickly leads to more hard loading even though it risks raising the water pressure in the cargoes. And pressure to deliver the same tonnage of cargo as was loaded may discourage the crew of the vessel draining cargoes during the voyage.

What's the solution?

To tackle these problems, the shipping industry needs to better understand the material behaviour of solid bulk cargoes now being transported and prescribe appropriate testing. New technology could help. Sensors in a ship's hold could monitor the water pressure of the bulk cargo. Or the surface of the cargo could be monitored, for example using lasers, to identify any changes in its position.

The challenge is developing a technology that is cheap enough, quick to install and robust enough to survive loading and unloading of the cargo. If these challenges can be overcome, combining data on the water pressure and movement of the cargo with information on the weather and the ship's movements could produce a real-time warning of whether the cargo was about to liquefy.

The crew could then act to prevent the water pressure in the cargo rising too much, for example, by draining water from the cargo holds (to reduce water pressure) or changing course of the vessel to avoid particularly bad weather (to reduce ship motions). Or if that were not possible, they could evacuate the vessel. In this way, this phenomenon of solid bulk cargo liquefaction could be overcome, and fewer ships and crew would be lost at sea.

(THE CONVERSATION / August 29, 2018, https://theconversation.com/mystery-of-the-cargo-ships-that-sink-when-their-cargo-suddenly-liquefies-101158?utm_source=twitter&utm_medium=twitterbutton)

(εστάλη από τον συνάδελφο Γιάννη Μεταξά)

Slope stability evaluation of iron ore fines during marine transport in bulk carriers

Michael C. Munro, Abbas Mohajerani

Abstract

A commodity, such as iron ore fines, shifting in the hold of a bulk carrier can lead to the vessel listing or capsizing. The objective of this study is to investigate the factors of safety pertaining to slope failure for both untrimmed and trimmed cargoes of iron ore fines during marine transportation. To determine the shear strength parameters needed to perform this analysis, triaxial testing was performed on samples of iron ore fines under varying densities and moisture contents. Using the shear strength parameters of the material, the Morgenstern–Price method of slices and infinite slope analysis, referred to as rotational and translational slope stability analyses, were used to determine the factors of safety against slope failure. The study concludes that, considering a factor of safety of 1.5, an untrimmed cargo of iron ore fines is unstable at angles of heel that bulk carriers are expected to experience during a typical voyage. If the cargo is trimmed it is shown to be significantly more stable. Results support the recommendation that it become mandatory for cargoes of iron ore fines to undergo trimming to reduce the chance of

slope failure occurring, which may result in the loss of human life and industry assets.

Canadian Geotechnical Journal, 2018, 55(2): 258-278, https://doi.org/10.1139/cgj-2016-0468

(http://www.nrcresearchpress.com/doi/abs/10.1139/cgj-2016-0468#.W5KXRLh9g2w)

Warnings Abounded Before Massive Alaska Landslide and Tsunami

A massive landslide struck Alaska's Tyndall Glacier in 2015.

A massive landslide and tsunami that denuded the slopes of an Alaskan fjord could reveal warning signs that could help predict future disasters.

In a new paper, researchers described the geological fingerprints of the tsunami, which tore through Taan Fjord on Oct.17, 2015, at an estimated 100 mph (162 km/h). Using satellite imagery and field-based measurements, the team discovered that the slope was displaying signs of instability for at least two decades before it failed.

The "geologic evidence can help [us] understand past occurrences of similar events and might provide forewarning," the researchers wrote Thursday (Sept. 6) in the journal Scientific Reports. (σ.σ. το άρθρο παρατίθεται στο παρόν τεύχος στην ενότητα ΑΡΘΡΑ)

The fall

Taan Fjord sits in Wrangell-St. Elias National Park and Preserve in southeastern Alaska. The rugged landscape is dotted with glaciers, including the Tyndall Glacier, which used to fill the entirety of Taan Fjord. Between 1961 and 1991, however, the glacier retreated 10.5 miles (17 kilometers) to the end of the fjord.

As glaciers retreat and permafrost melts, the rocky hillsides once supported by all that ice become unstable, wrote the team of researchers led by the University of Washington Tacoma's Dan Shugar and environmental nonprofit Ground Truth Trekking's Bretwood Higman. The situation is made worse by Alaska's restive nature; minor earthquakes regularly jolt the fjord walls.

Those factors may explain what happened in 2015, when an enormous chunk of hillside in front of the Tyndall Glacier suddenly failed. Fortunately, no human eye was around to witness the catastrophe, which spawned seismic waves equivalent to a magnitude-4.9 earthquake. Roughly 180 billion tons of rock and dirt crashed toward the fjord, about one-third of the material landing on the glacier itself and the other two-thirds hitting the water. The resulting tsunami traveled 633 feet (193 meters) up the opposite side of the fjord; down-fjord, it reached 328 feet (100 m) in many places. After the wave of debris and water hit, hillsides that had once been covered with 32-foot (10 m) trees were stripped entirely bare.

Warning signs

It's unknown what triggered the final slope failure, the researchers wrote. About 2 minutes before the tsunami, the seismic waves from a magnitude-4.1 earthquake that hit more than 300 miles (500 km) away reached the fjord. The shaking wouldn't have been much, nor would it have been unusual for the region, the authors wrote, but it might have been enough. The previous months had also been unusually wet, which could have further destabilized the slope.

Whatever the reason that the slope failed at that moment, the landslide was inevitable, the researchers wrote. Satellite imagery revealed that the slope had been slumping since 1996, and depressed areas called grabens — created as the surface of the hillside stretched downward — had been visible from above since 1995. For two decades, the researchers found, the signs of a failing slope were apparent from satellite data.

The deposits that the tsunami left behind were unique, unlike those left by other modern tsunamis, the researchers found. These deposits occurred in three distinct layers, one consisting of fine sands, one made up of cobble-size rocks between about two and ten inches (5 to 25 cm) in diameter and boulders, and a final layer made of a mixture of everything from sand to boulders 16 feet (5 m) in diameter.

Seeing those patterns in a modern, well-documented landslide tsunami provides new clues about what to look for in the geological record when searching for ancient tsunamis, the researchers wrote. The findings also hint at ways to monitor unstable hillsides as climate change continues to force the retreat of the glaciers. Taan Fjord is remote, but the Tidal Fjord in tourist-heavy Glacier Bay, Alaska, saw a landslide in June 2016. Fortunately, the debris from that event didn't reach the water, avoiding a tsunami. In Rink Fjord in Greenland in 2017, a landslide tsunami had a far more tragic outcome: Four people died.

"More such landslides are likely to occur as mountain glaciers continue to shrink and alpine permafrost thaws," the researchers wrote.

(Stephanie Pappas, Live Science Contributor / LIVESCIENCE, September 8, 2018, https://www.livescience.com/63527-massive-alaska-landslide-tsunami-warnings.html?utm_source=ls-newsletter&utm_medium=email&utm_campaign=20180908-ls)

Bridge that collapsed six hours after opening was built without geotech investigation of riverbed: Reeve

Bridge expert calls lack of geotechnical work "irregular"

A section of the newly-built Dyck Memorial Bridge over the Swan River in the RM of Clayton collapsed hours after the bridge was opened to the public.

The Reeve of the rural municipality (RM) of Clayton says the bridge that collapsed six hours after it opened was built without having geotechnical investigation done on the riverbed it stood on. A bridge building expert calls that approach "irregular."

The Dyck Memorial Bridge, located in the RM of Clayton about 300 kilometres east of Saskatoon, collapsed Friday shortly after it was opened.

RM of Clayton Reeve Duane Hicks told CBC he believes the contractor and engineer did everything right and this was an "act of God."

"It seems like something under the riverbed let go and a row of pilings sunk," Hicks said. "I don't know who to blame but I figure God built most of this for us."

He said the issue was with five underwater pilings and "the whole five of them just went straight down. Boom. Four feet."

"So something tells me that something underneath the ground happened. I don't know what it was. They don't know what it was. Nobody knows what it is."

Geotechnical investigation not done, Reeve said

Hicks said a geotechnical study of the riverbed wasn't done before the bridge was built. Inertia, the engineering company for the project, declined to answer media questions and referred calls to the RM.

Initially, Hicks told CBC the geotech work wasn't done because it's not possible to do that work under the river.

"You can't drill through water," he said. "You can't do it. You can't take underground samples."

He said people in the industry he spoke to told him standard practice was to drill holes on each shore and assume the soil under the river would be the same.

"All the bridge people that we've talked to since this has happened indicate that's what they do," said Hicks. He said he is not sure if Inertia did drill holes on the shore when building the Dyck Memorial bridge.

Paul Gauvreau, a bridge-building expert from the University of Toronto, disputes Hicks's claim.

"I think it's irregular that a proper geotechnical program wasn't done for the piers in the water," said Gauvreau, an engineering professor at the U of T. "And it is not correct to say that it can't be done in a river. It's done all the time."

He said that is even the case for a small bridge like the one in the RM of Clayton.

"Perhaps for smaller bridges you can get by with a less extensive geotechnical program, but generally speaking you're going to have at least one test hole at the location of every pier including piers in the water," he said.

Geotechnical investigation too expensive, says Reeve

Later in the interview, Hicks acknowledged that perhaps drilling can be done under the riverbed, but said it would be costly.

"Well the fact of the matter is we don't have a heck of a lot of money," said Hicks.

According to Sasktenders, the bridge contract was worth $325,000. Hicks said it's difficult to justify a huge budget for this bridge, which he estimated would have about 1,000 vehicles crossing it annually.

Gauvreau also disputed Hick's claim about the cost of this work.

"A geotechnical investigation relative to the cost to build a bridge is not that expensive. It's being sort of penny-wise and pound-foolish by not doing the geotechnical investigation," he said.

Furthermore, he said making this sort of decision based on cost is not appropriate.

"It's not an insignificant cost but the point is that's not a cost that you can shave," Gauvreau said.

New bridge in three to four weeks?

Hicks said he'd like to see the new bridge completed within the next three to four weeks, though he acknowledges that may not be realistic.

This bridge in the RM of Clayton in Saskatchewan collapsed just hours after it opened.

He said the construction company is going to rebuild the bridge at no cost to taxpayers.

Hicks said the company will be going to extraordinary lengths to ensure the piles are solid and immovable.

"They're going to go down deeper. And just keep going down and down and down," he said.

"I don't know what I could ask them to do differently quite frankly."

Hicks says the Association of Professional Engineers and Geoscientists of Saskatchewan (APEGS) is conducting an investigation.

APEGS executive director Bob McDonald refused to confirm or deny that.

McDonald did tell CBC the organization can only investigate if it receives a complaint or a request by the organization's council.

He said the only way the organization would ever confirm an investigation had been conducted is if it found professional

(Geoff Leo, Senior Investigative Journalist / CBC News, September 20, 2018, https://www.cbc.ca/amp/1.4829890)

Το άρθρο υπεδείχθη από τον συνάδελφο Γιέωργο Κοσσένα.

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΣΕΙΣΜΟΙ

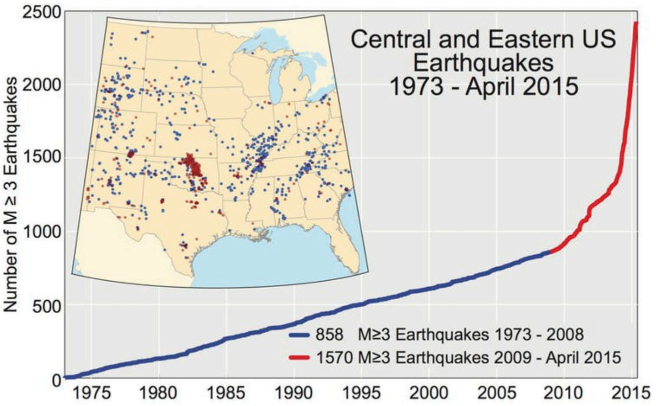
Injecting wastewater underground can cause earthquakes up to 10 kilometers away

Earthquakes in the central and eastern United States have increased dramatically in the last decade as a result of human activities. Enhanced oil recovery techniques, including dewatering and hydraulic fracturing, or fracking, have made accessible large quantities of oil and gas previously trapped underground, but often result in a glut of contaminated wastewater as a byproduct.

Energy companies frequently inject wastewater deep underground to avoid polluting drinking water sources. This process is responsible for a surge of earthquakes in Oklahoma and other regions.

The timing of these earthquakes makes it clear that they are linked with deep wastewater injection. But earthquake scientists like me want to anticipate how far from injection sites these quakes may occur.

In collaboration with a researcher in my group, Thomas Goebel, I examined injection wells around the world to determine how the number of earthquakes changed with the distance from injection. We found that in some cases wells could trigger earthquakes up to 10 kilometers (6 miles) away. We also found that, contradictory to conventional wisdom, injecting fluids into sedimentary rock rather than the harder underlying rock often generates larger and more distant earthquakes.



Cumulative number of earthquakes with a magnitude of 3.0 or larger in the central and eastern United States, 1973-2015.

Transmitting pressure through rock

Assessing how far from a well earthquakes might occur has practical consequences for regulation and management. At first glance, one might expect that the most likely place for wastewater disposal to trigger an earthquake is at the site of the injection well, but this is not necessarily true.

Since the 1970s, scientists and engineers have understood that injecting water directly into faults can jack the faults open, making it easier for them to slide in an earthquake. More recently it has become clear that water injection can also cause earthquakes in other ways.

For example, water injected underground can create pressure that deforms the surrounding rock and pushes faults toward slipping in earthquakes. This effect is called poroelasticity. Because water does not need to be injected directly into the fault to generate earthquakes via poroelasticity, it can trigger them far away from the injection well.

Deep disposal wells are typically less than a foot in diameter, so the chance of any individual well intersecting a fault that is ready to have an earthquake is quite small. But at greater distances from the well, the number of faults that are affected rises, increasing the chance of encountering a fault that can be triggered.

Of course, the pressure that a well exerts also decreases with distance. There is a trade-off between decreasing effects from the well and increasing chances of triggering a fault. As a result, it is not obvious how far earthquakes may occur from injection wells.

Surveillance video from a grocery store in Crescent, Oklahoma captures impacts of a magnitude 4.2 quake, July 27, 2015.

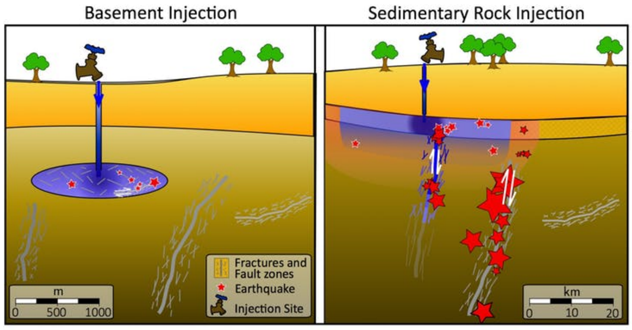
Where to inject?

To assess this question, we examined sites around around the world that were well-isolated from other injection sites, so that earthquakes could clearly be associated with a specific well and project. We focused on around 20 sites that had publicly accessible, high-quality data, including accurate earthquake locations.

We found that these sites fell into two categories, depending on the injection strategy used. For context, oil and gas deposits form in basins. As layers of sediments gradually accumulate, any organic materials trapped in these layers are compressed, heated and eventually converted into fossil fuels. Energy companies may inject wastewater either into the sedimentary rocks that fill oil and gas basins, or into older, harder underlying basement rock.

At sites we examined, injecting water into sedimentary rocks generated a gradually decaying cloud of seismicity out to great distances. In contrast, injecting water into basement rock generated a compact swarm of earthquakes within a kilometer of the disposal site. The larger earthquakes produced in these cases were smaller than those produced in sedimentary rock.

This was a huge surprise. The conventional wisdom is that injecting fluids into basement rock is more dangerous than injecting into sedimentary rock because the largest faults, which potentially can make the most damaging earthquakes, are in the basement. Mitigation strategies around the world are premised on this idea, but our data showed the opposite.



How wastewater injection can make earthquakes: In basement rocks (left), injection activates faults in the small region directly connected to the added water, shown in blue. In sedimentary injection (right), an additional halo of squeezed rock, shown in red, surrounds the pressurized fluid and can activate more distant faults.

Why would injecting fluids into sedimentary rock cause larger quakes? We believe a key factor is that at sedimentary injection sites, rocks are softer and easier to pressurize through water injection. Because this effect can extend a great distance from the wells, the chances of hitting a large fault are greater. Poroelasticity appears to be generating earthquakes in the basement even when water is injected into overlying sedimentary rocks.

In fact, most of the earthquakes that we studied occurred in the basement, even at sedimentary injection sites. Both sedimentary and basement injection activate the deep, more dangerous faults – and sedimentary sequences activate more of them.

Although it is theoretically possible that water could be transported to the basement through fractures, this would have to happen very fast to explain the rapid observed rise in earthquake rates at the observed distances from injection wells. Poroelasticity appears to be a more likely process.

Avoiding human-induced quakes

Our findings suggest that injection into sedimentary rocks is more dangerous than injecting water into basement rock, but this conclusion needs to be taken with a rather large grain of salt. If a well is placed at random on Earth's surface, the fact that sedimentary injection can affect large areas will increase the likelihood of a big earthquake.

However, wells are seldom placed at random. In order to efficiently dispose of wastewater, wells must be in permeable rock where the water can flow away from the well. Basement rocks are generally low permeability and therefore are not very efficient areas in which to dispose of wastewater.

One of the few ways that basement rocks can have high permeability is when there are faults that fracture the rock. But, of course, if these high permeability faults are used for injection, the chances of having an earthquake skyrocket. Ideally, injection into basement rock should be planned to avoid known larger faults.

If a well does inject directly into a basement fault, an anomalously large earthquake can occur. The magnitude 5.4 Pohang earthquake in South Korea in 2017 occurred near a geothermal energy site where hydraulic injection had recently been carried out.

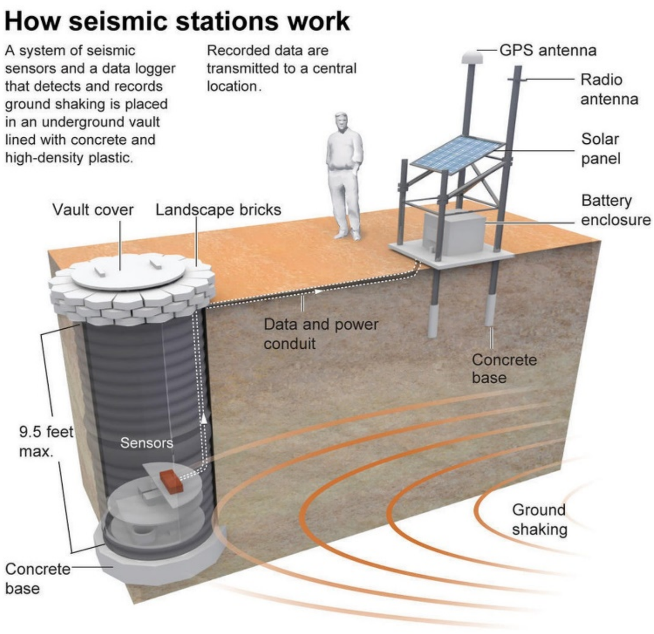
The important insight of this study is that injection into sedimentary rocks activates more of these basement rocks than even direct injection. Sedimentary rock injection is not a safer alternative to basement injection.

(THE CONVERSATION / Emily Brodsky, Professor of Earth and Planetary Sciences, University of California, Santa Cruz, August 31, 2018, https://theconversation.com/injecting-wastewater-underground-can-cause-earthquakes-up-to-10-kilometers-away-102008)

Earthquake early-warning system successfully sent alarm before temblor felt in Pasadena

California's nascent earthquake early-warning system had another successful run Tuesday night when a 4.4 magnitude temblor hit the La Verne area.

The quake was too small to cause much damage but was felt over a wide area.



Seismologist Lucy Jones told reporters at Caltech on Tuesday night that the system sent out a warning to her location in Pasadena three seconds before the shaking began to be felt there. The amount of warning time depends on how close the person receiving the alert is to the earthquake's epicenter.

And residents who live near the epicenter said the quake packed a punch. Vickie Carillo was sitting with her son on the couch watching "Jaws 2" when they felt the shaking start.

"It was like if somebody had grabbed it and was shaking the house," she said.

> #Earthquake: @DrLucyJones demonstrates how early warning system worked at @Caltech lab in #Pasadena. Got 3 second warning before quake. pic.twitter.com/u1nusr8EAD
>
> — Robert Kovacik (@RobertNBCLA) August 29, 2018

The earthquake early-warning system is under development by the U.S. Geological Survey and is only available to a limited array of testers, but it is expected that more people will be eligible to test it later this year.

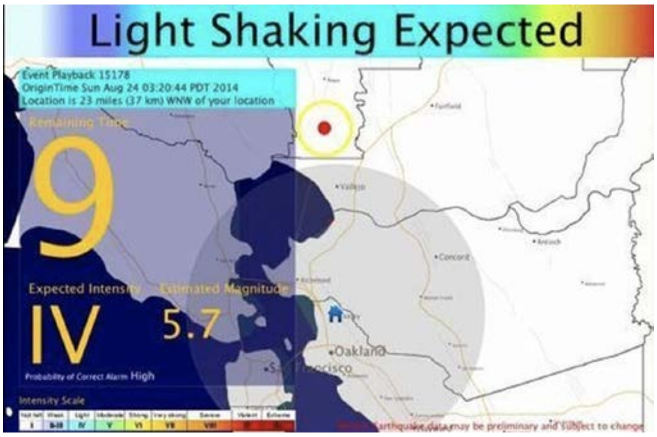
The system already has proved successful. The alert gave scientists at USC a 10-second warning before waves arrived from a 5.3 temblor that hit near the Channel Islands in April. And in 2014, the prototype early-warning system gave San Francisco eight seconds of warning before a 6.0 magnitude earthquake hit Napa.

It works on a simple principle: The shaking from an earthquake travels at the speed of sound through rock — which is slower than the speed of today's communications systems.

For example, it would take more than a minute for a magnitude 7.8 earthquake that starts at the Salton Sea and travels up the state's longest fault, the San Andreas, to shake Los Angeles, 150 miles away. An early-warning system would give L.A. residents crucial seconds, and perhaps even more than a minute, to prepare.

It got a significant boost in the federal budget signed into law in March, defying an earlier proposal by President Trump to end federal funding for the program.

As part of the $1.3-trillion budget bill approved by Congress and signed by Trump, officials approved $22.9 million for the project. That more than doubles the $10.2 million it got in the previous year's budget.



Early warning for the Napa quake (Los Angeles Times)

A seismic early-warning system for the West Coast has been under development for years by the USGS, the nation's lead earthquake monitoring agency, but the project has remained short of funds.

It's estimated that building a full system covering the West Coast would cost at least $38.2 million, with about $16.1 million annually to operate and maintain it.

The USGS has said it planned to begin issuing limited public alerts from the system by the end of this year, as long as funding wasn't cut. Southern California is one area where the network of seismic sensors is dense enough at present to begin early warnings.

For the system to go live all along the West Coast, more sensors need to be installed in Washington, Oregon and sparsely populated areas of Northern California. More than 850 earthquake-sensing stations are online, but about 800 more are needed, officials said. Too few sensors could mean, for instance, that Los Angeles would experience delays in warnings from an earthquake that starts in Monterey County and barrels south along the San Andreas fault.

Along the West Coast, facilities including airports, oil refineries, pipelines, schools, universities, city halls and libraries are already testing or planning to test the system.

Hospitals in California are testing audible notifications, broadcast from fire alarm equipment, so steps can be taken such as surgeons engaged in operations removing scalpels from patients.

Condominium towers testing the system have been similarly rewired to give residents time to drop, cover and hold on before shaking arrives.

Some office buildings have also been wired to automatically bring elevators to the nearest floor, preventing people from being trapped after an earthquake.

(Alejandra Reyes-Velarde / Los Angeles Times, Aug 29, 2018, http://www.latimes.com/local/lanow/la-me-quake-early-warning-20180829-story.html#)

cs ≀

Μελέτη για τσουνάμι στην Κρήτη - Οι ζημιές και οι χρόνοι εκκένωσης των παραλιών

Μια διεθνώς πρωτοποριακή μέθοδο υπολογισμού του κόστους βλαβών στα κτίρια παράκτιων περιοχών σε περίπτωση ισχυρού **τσουνάμι**, αλλά και εύρεσης των βέλτιστων διαδρομών και των χρόνων που απαιτούνται για την εκκένωση της παραλίας ανέπτυξε η ομάδα πρόγνωσης σεισμών και τσουνάμι του **Γεωδυναμικού Ινστιτούτου Αθηνών**, υπό το διευθυντή Ερευνών **Γεράσιμο Παπαδόπουλο.**

Η μεθοδολογία των ερευνητών, που δημοσιεύτηκε στο έγκυρο επιστημονικό περιοδικό «Pure and Applied Geophysics», μπορεί να αξιοποιηθεί από κυβερνήσεις για προληπτικούς σκοπούς, όπως για να θωρακίσουν τα κτήρια, να τα κάνουν πιο «γερά» αλλά και για ν**α εντοπίσουν τυχόν εμπόδια στην προσπάθεια διαφυγής από τους πολίτες.**

Η περίπτωση στο Μάτι ήταν ενδεικτική τέτοιων τεράστιων δυσκολιών εξαιτίας της άναρχης ρυμοτομίας. **Αντίστοιχα εμπόδια εντοπίστηκαν και στην παράκτια περιοχή του Γαζίου, δυτικά του Ηρακλείου Κρήτης,** όπου εφαρμόστηκε δοκιμαστικά η μεθοδολογία της ομάδας του Γεωδυναμικού Ινστιτούτου.

Με την αντίθετη πορεία σε σχέση με το Μάτι, τη διαφυγή δηλαδή των πολιτών από τη θάλασσα προς την ενδοχώρα, διαπιστώθηκε ότι **απαιτούνται... 21 λεπτά για να διανύσουν ένα χιλιόμετρο**απόσταση με μέση ταχύτητα τα 3 χλμ./ώρα.

«Χρησιμοποιώντας προληπτικά τη μέθοδο αυτή, μπορείς να εντοπίσεις ένα σωρό τρωτά σημεία. Οπως, για παράδειγμα, να διαχειριστείς συρματοπλέγματα που κόβουν το δρόμο. Επίσης, **να φτιάξεις κανονισμούς ώστε τα σπίτια να είναι γερά απέναντι σε ένα τσουνάμι.** Και φυσικά πρέπει να γνωρίζεις ποιες είναι οι συνέπειες ενός τέτοιου φαινομένου», εξηγεί στον Ελεύθερο Τύπο της Κυριακής ο σεισμολόγος και διευθυντής Ερευνών του Γεωδυναμικού Ινστιτούτου, Γεράσιμος Παπαδόπουλος.

Παρόλο που ο ειδικός είναι **απαισιόδοξος ότι στην Ελλάδα μπορεί να αξιοποιηθεί μια τέτοια καινοτόμα επιστημονική μέθοδος**, δεδομένου, όπως υποστηρίζει, ότι η πολιτική προστασία «πάσχει» και πρόκειται για ένα διαχρονικό φαινόμενο, ευελπιστεί ότι θα αποτελέσει βάση για πρόληψη σε άλλες χώρες.

Τα δεδομένα άλλωστε που χρησιμοποίησαν οι ερευνητές είναι από τον Ειρηνικό Ωκεανό, όπου και εκδηλώνονται συχνά τσουνάμι. Πιο αναλυτικά, σύμφωνα με τον κ. Παπαδόπουλο, η μεθοδολογία που ανέπτυξαν βασίζεται σε προσομοιώσεις και σε σύστημα γεωγραφικών πληροφοριών, ευρέως γνωστό ως GIS. **Επιλέχθηκε η περιοχή της Κρήτης ώστε να εφαρμοστεί δοκιμαστικά η μέθοδος, καθώς εκεί ήταν που είχε προκληθεί μεγάλο τσουνάμι το 17ο αιώνα π.Χ. μετά την έκρηξη του ηφαιστείου της Σαντορίνης.** Συγκεκριμένα, αναλύθηκε η παράκτια ζώνη πέντε χιλιομέτρων δυτικά του Ηρακλείου στην οποία, στην τότε μεγάλη έκρηξη, είχε προκληθεί τσουνάμι ύψους 14 μέτρων. Το πόσα κτίρια υπάρχουν στην περιοχή βρέθηκε με βάση την Ελληνική Στατιστική Υπηρεσία (ΕΛ.ΣΤΑΤ.) και την απογραφή του 2011.

Στη συνέχεια εκτιμήθηκε **πόσα κτίρια είναι βαθμού 5, δηλαδή υπό πλήρη κατάρρευση**, πόσα βαθμού 4, δηλαδή μερική κατάρρευση κ.ο.κ.

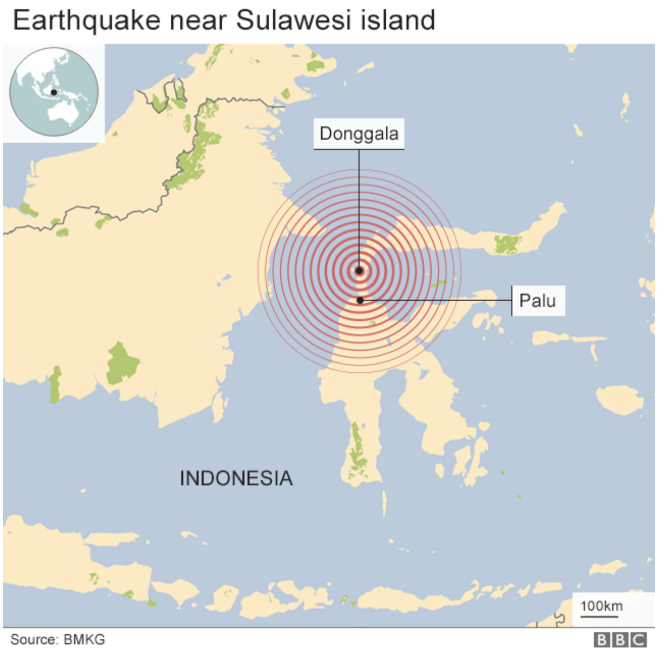
Για να υπολογιστεί το κόστος ανακατασκευών ή επισκευών, πήραν το κοστολόγιο που επισήμως η κυβέρνηση όρισε στους σεισμούς της Κεφαλονιάς το 2014. Για μερική ανοικοδόμηση, για παράδειγμα, υπολογίζεται κόστος 500 ευρώ το τετραγωνικό. Ετσι, **το συνολικό κόστος για τα πέντε χιλιόμετρα της Κρήτης εκτιμάται στα 55 εκατομμύρια ευρώ.**

Η μέθοδος εντάσσεται σε ευρωπαϊκό πρόγραμμα έρευνας και χρηματοδοτείται από την Ευρωπαϊκή Ενωση και ο βασικός στόχος είναι να γνωρίζει κάποιος εκ των προτέρων τις συνέπειες από ένα τσουνάμι. **Στην Ελλάδα το τσουνάμι είναι σπάνιο φαινόμενο, όπως λέει ο κ. Παπαδόπουλος, ωστόσο δεν παύει να υπάρχει.** Τις περισσότερες φορές απλά, μετά από ισχυρούς σεισμούς, πραγματοποιείται μικρό τσουνάμι που δεν προκαλεί ζημιές. «**Το πότε θα συμβεί τσουνάμι κανείς δεν το γνωρίζει. Η σπανιότητα του φαινομένου ωστόσο δεν εγγυάται ασφάλεια**», λέει ο κ. Παπαδόπουλος και προσθέτει ότι στο σύστημα πολιτικής προστασίας στην Ελλάδα δεν έχει πραγματοποιηθεί καμία βελτίωση από το 1995 και μετά. Σύμφωνα με τον ίδιο, παραμένουν διαχρονικά υποστελεχωμένες οι υπηρεσίες της και με πολλαπλά προβλήματα, τα οποία φάνηκαν με τον πλέον εμφατικό τρόπο στην πρόσφατη τραγωδία στο Μάτι.

(Newsroom, CNN Greece, Κυριακή, 23 Σεπτεμβρίου 2018, https://www.cnn.gr/news/ellada/story/147861/meleti-gia-tsoynami-stin-kriti-oi-zimies-kai-oi-xronoi-ekkenosis-ton-paralion)

Εντυπωσιακό video από το tsunami μετά τον πρόσφατο σεισμό στην Ινδονησία

Σεισμός μεγέθους 7.5 έπληξε την παραθαλάσσια πόλη Palu στο νησί Sulawesi της Ινδονησίας την 28η Σεπτεμβρίου 2018.



Τον σεισμό ακολούθησε tsunami, ύψους 2÷3 m:

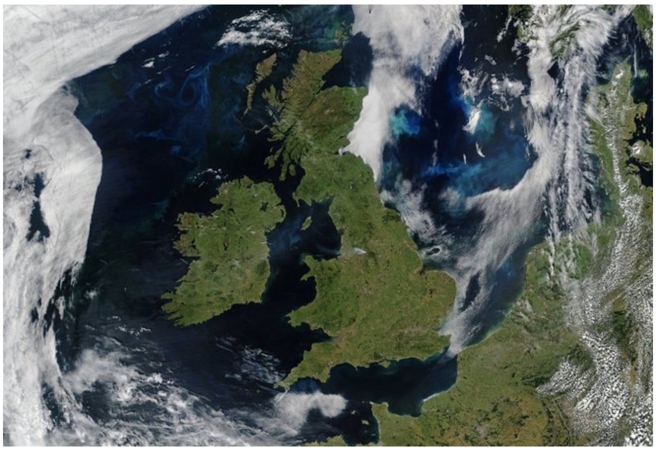
https://www.facebook.com/groups/940725076073595/permalink/1528531283959635/

(Η ανάρτηση στο facebook έγινε από τον συνάδελφο και μέλος της ΕΕΕΕΓΜ Γιάννη Μεταξά).

Φαίνεται ότι η κατάκλυση της παραλίας με νερό έγινε πριν από την άφιξη του κύματος. Προσέξτε την κατάρρευση του τρούλου του τζαμιού, παρά το ότι ήταν στο μέσον της οικοδομής, αλλά και το ότι η διαφημιστική πινακίδα παρέμεινε ανέπαφη (ελαχίστη επιφάνεια προσβολής στο κύμα).

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΓΕΩΛΟΓΙΑ

Ancient Three-Way Collision Formed British Mainland



On June 17, 2018, satellites captured images of the United Kingdom and Ireland.

Parts of Britain are a lot more like France than ever before realized.

In fact, Cornwall and south Devon on the British mainland are basically part of France — at least, geologically speaking. New research finds that these areas all derive from an ancient bit of continental crust called Armorica. Previously, the British mainland was thought to have been formed from only a piece of crust called Avolonia and a segment of the precursor to North America, Laurentia. The new research suggests that it was instead a three-way merger.

Understanding this process requires going back 400 million years ago, well before the formation of the famous supercontinent Pangea, which formed around 300 million years ago. It was the early Paleozoic, and most of the above-sea-level crust on Earth was divided into several continents, the largest being Gondwana, which contained the continental crust that would become the modern southern-hemisphere continents. The others were Avalonia (the precursor to Canada and much of Europe), Laurentia (the precursor to North America), Barentsia, Baltica, Siberia and North and South China.

Ancient collisions

Around 400 million years ago, Avalonia scrunched into a piece of Laurentia. This merger was previously thought to have created the land that would later merge into Pangea and then break up again into the modern-day British mainland.

However, a new study published Sept. 14 in the journal Nature Communications finds that there was another fragment involved in this ancient dance: Armorica. Like Avalonia, Armorica was a fragment of crust that had torn off Gondwana and was wandering toward Laurentia.

Today, the land that was once Armorica is part of France and mainland Europe.

"It has always been presumed that the border of Avalonia and Armorica was beneath what would seem to be the natural boundary of the English Channel," study co-author Arjan Dijkstra, a lecturer in igneous petrology at the University of Plymouth, said in a statement.

Here's how researchers think the British Isles may have formed.

But it's not, Dijkstra and his co-author Callum Hatch, now a geological specimen preparatory at the Natural History Museum in London, discovered. Instead, the line runs through Devon and Cornwall.

Ancient bonds

The researchers discovered this geological boundary by studying ancient magmas called lamprophyres and potassic lavas from 22 different sites in southwest Britain. They examined atomic variations, or isotopes, of the elements neodymium and strontium in the rock samples.

Callum Hatch, the Natural History Museum in London, inspects rock samples at one of the study sites called Knowle Hill Quarry.

They found two very different variants of rock north and south of an imaginary line through Devon and Cornwall. In particular, the rocks south of the boundary were rich in radiogenic strontium and showed differences in their levels of neodymium isotopes compared with the rocks north of the boundary. The southern rocks precisely matched lamprophyres of the same age found in Europe, on what was once Armorica.

The results might explain why southwestern Britain is rich in the metals tin and tungsten, the researchers said. Tin and tungsten are also common in Brittany in the northwest of France, but not in the rest of Britain.

"We always knew that around 10,000 years ago you would have been able to walk from England to France," Dijkstra said in the statement. "But our findings show that millions of years before that, the bonds between the two countries would have been even stronger."

(Stephanie Pappas, Live Science Contributor / LIVESCIENCE, September 17, 2018, https://www.livescience.com/63599-ancient-formation-of-british-mainland.html?utm_source=ls-newsletter&utm_medium=email&utm_campaign=20180917-ls)

Mapping a hidden terrane boundary in the mantle lithosphere with lamprophyres

Arjan H. Dijkstra & Callum Hatch

Abstract

Lamprophyres represent hydrous alkaline mantle melts that are a unique source of information about the composition of continental lithosphere. Throughout southwest Britain, post-Variscan lamprophyres are (ultra)potassic with strong incompatible element enrichments. Here we show that they form two distinct groups in terms of their Sr and Nd isotopic compositions, occurring on either side of a postulated, hitherto unrecognized terrane boundary. Lamprophyres emplaced north of the boundary fall on the mantle array with ε_{Nd} −1 to +1.6. Those south of the boundary are enriched in radiogenic Sr, have initial ε_{Nd} values of −0.3 to −3.5, and are isotopically indistinguishable from similar-aged lamprophyres in Armorican massifs in Europe. We conclude that an Armorican terrane was juxtaposed against Avalonia well before the closure of the Variscan oceans and the formation of Pangea. The giant Cornubian Tin-Tungsten Ore Province and associated batholith can be accounted for by the fertility of Armorican lower crust and mantle lithosphere.

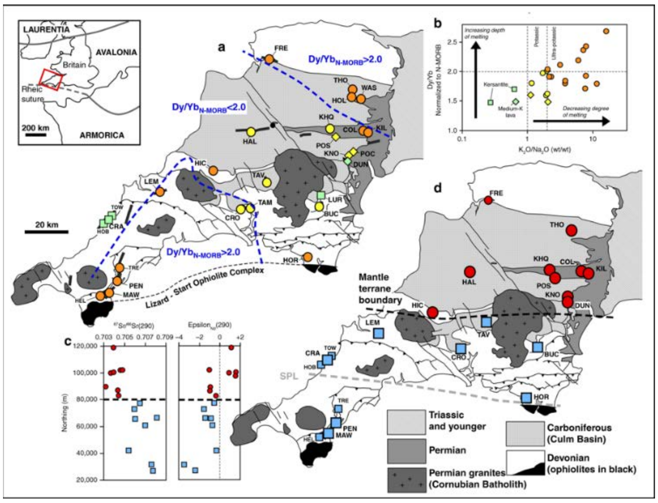


Fig. 1. Geospatial analysis of post-Variscan lamprophyre geochemistry in southwest Britain. Inset map shows location of study area, with the generally assumed location of the Rheic suture marked by the Lizard-Start ophiolites complex.

(Published: 14 September 2018, *Nature Communications*, Volume 9, Article number: 3770 (2018), https://www.nature.com/articles/s41467-018-06253-7)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΠΕΡΙΒΑΛΛΟΝ

Melting Arctic Permafrost Releases Acid that Dissolves Rocks

Runoff from melting permafrost in Alaska flows toward the sea.

As temperatures rise in the Arctic, permafrost — permanently frozen ground — is defrosting at an alarming rate. But the permafrost isn't the only thing in the Arctic that's melting.

Exposed rock that was once covered in ice is dissolving, eaten away by acid. And the effects of this acid bath could have far-reaching impacts on global climate, according to a new study.

Icy permafrost is rich in minerals, which are released when the ice melts. The minerals then become vulnerable to chemical weathering, or the breakdown of rock through chemical reactions, scientists recently reported. They investigated areas once covered by permafrost in the western Canadian Arctic, finding evidence of weathering caused by sulfuric acid, produced by sulfide minerals that were released when the permafrost melted.

Another type of naturally occurring chemical erosion is caused by carbonic acid, and it also dissolves Arctic rock. But although carbonic-acid weathering locks carbon dioxide (CO2) in place, sulfuric-acid erosion releases CO2 into the atmosphere, and it does so in quantities that were not previously accounted for, researchers wrote in the study.

Dramatic changes are underway in the Arctic, which is warming twice as fast as any other location on Earth. Sea ice is rapidly dwindling, which reduces the ocean's heat-reflecting cover, accelerating the rise of ocean temperatures. And polar bears, which depend on sea-ice cover to hunt for seals, are losing their hunting grounds, and have a harder time finding enough to eat.

On land, melting permafrost is shaping new landscapes, through a process called thermokarst — a term for thawing-driven erosion that originated in Russia, according to the U.S. Geological Survey (USGS).

Thermokarst creates land formations such as lakes, pits and sinkholes, and it was previously unknown how this process could affect weathering of exposed minerals, and how that might then impact CO2 release, according to the study.

"These processes may influence the permafrost carbon-climate feedback, but have received little attention," the scientists reported.

Over geologic timescales, weathering caused by carbonic acid can help to regulate climate, by trapping CO2 and restricting its transfer into the atmosphere. But the researchers found that thermokarst in regions that were rich in sulfides drove production of sulfuric acid, rather than carbonic acid, and thereby released quantities of CO2.

An estimated 1,400 billion tons of carbon are stored in permafrost, Live Science previously reported (https://www.livescience.com/59860-melting-permafrost-doomsday-methane-bomb.html), and as thawing continues and thermokarst activity intensifies, sulfide-rich regions will continue to transfer CO2 from its icy tomb. However, how that will balance out against the permafrost regions that still produce carbon-trapping carbonic acid is unknown, according to the study.

The findings were published online Sept. 5 in the journal Geophysical Research Letters.

(Mindy Weisberger, Senior Writer / LIVESCIENCE, September 18, 2018, https://www.livescience.com/63612-arctic-acid-permafrost.html?utm_source=ls-newsletter&utm_medium=email&utm_campaign=20180919-ls)

Mineral Weathering and the Permafrost Carbon-Climate Feedback

Scott Zolkos, Suzanne E. Tank and Steven V. Kokelj

Abstract

Permafrost thaw in the Arctic enables the biogeochemical transformation of vast stores of organic carbon into carbon dioxide (CO_2). This CO_2 release has significant implications for climate feedbacks, yet the potential counterbalance from CO_2 fixation via chemical weathering of minerals exposed by thawing permafrost is entirely unstudied. We show thermokarst in the western Canadian Arctic enables rapid weathering of carbonate tills, driven by sulfuric acid from sulfide oxidation. Unlike carbonic acid-driven weathering, this caused significant and previously undocumented CO_2 production and outgassing in headwater streams. Increasing riverine solute fluxes correspond with long-term intensification of thermokarst and reflect the regional predominance of sulfuric acid-driven carbonate weathering. We conclude that thermokarst-enhanced mineral weathering has potential to profoundly disrupt Arctic freshwater carbon cycling. While thermokarst and sulfuric acid-driven carbonate weathering in the western Canadian Arctic amplify CO_2 release, regional variation in sulfide oxidation will moderate the effects on the permafrost carbon-climate feedback.

Plain Language Summary

In the Arctic, perennially frozen ground (permafrost) in previously glaciated regions stores abundant minerals and is often ice-rich. Therefore, this permafrost can rapidly thaw and collapse, resulting in thermokarst and exposing minerals to breakdown by chemical weathering. Mineral weathering by carbonic acid fixes CO_2, making it less likely to enter the atmosphere. However, the effect of thermokarst on mineral weathering, carbon cycling, and rising atmospheric CO_2 levels is unknown. We show thermokarst enhances weathering in streams in the western Canadian Arctic and rapidly produces significant and previously undocumented CO_2, because carbonate weathering in this region is driven by sulfuric acid (from weathering of sulfide minerals) instead of carbonic acid. Long-term river chemistry reveals this weathering is in-

tensifying as thermokarst accelerates. Across the Arctic, increasing thermokarst will profoundly impact freshwater carbon cycling, yet the influence of weathering on climate feedbacks will depend on regional variation in the mineral composition of permafrost soils.

Geophysical Research Letters, 05 September 2018, https://doi.org/10.1029/2018GL078748, https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2018GL078748

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΛΟΙΠΑ

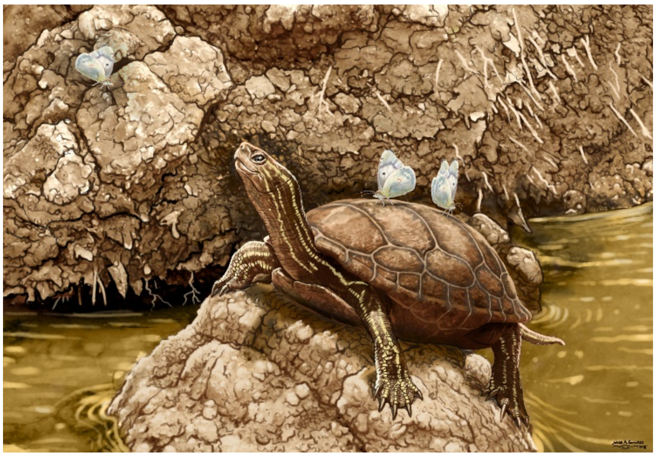
Νεροχελώνα του Αριστοτέλη - Mauremys Aristotelica

Από τον Καθηγητή Γεωλογίας Α.Π.Θ. Σπύρο Παυλίδη λάβαμε το παρακάτω Δελτίο Τύπου:

Η νεροχελώνα η αριστοτελική, ένα νέο είδος χελώνας 5 εκατομμυρίων ετών!

Το όνομά της τιμά τον Έλληνα πατέρα της επιστήμης και το Αριστοτέλειο Πανεπιστήμιο Θεσσαλονίκης

Η συνεισφορά του αρχαίου Έλληνα φιλοσόφου και επιστήμονα Αριστοτέλη στην παγκόσμια επιστήμη είναι τεράστια. Το 2014 ιδρύθηκε το Αριστοτέλειο Μουσείο Φυσικής Ιστορίας Θεσσαλονίκης (Α.Μ.Φ.Ι.Θ), ένα πρότυπο μουσειακό, ερευνητικό, εκπαιδευτικό και πολιτιστικό Κέντρο της Βόρειας Ελλάδας και της χώρας και περιλαμβάνει δραστηριότητες καταγραφής, έρευνας, μελέτης, προβολής, έκθεσης, διατήρησης και εκπαίδευσης, οι οποίες αντιστοιχούν στα γνωστικά αντικείμενα διαχρονικής και σύγχρονης γεω-βιοποικιλότητας του ελληνικού χώρου.Το 2016 ανακηρύχτηκε από την UNESCO ως «Έτος Αριστοτέλη», με αφορμή τη συμπλήρωση 2400 ετών από τη γέννησή του. Την ίδια χρονιά, παλαιοντολόγοι από το Τμήμα Γεωλογίας του Αριστοτελείου Πανεπιστημίου Θεσσαλονίκης ανακάλυπταν ένα νέο είδος χελώνας που ζούσε πριν από 5 εκατομμύρια χρόνια στην ευρύτερη περιοχή της γενέτειρας του Αριστοτέλη (Χαλκιδική, κεντρική Μακεδονία)!



Αναπαράσταση της νεροχελώνας της αριστοτελικής την ώρα που λιάζεται σε έναν ποταμό πριν από 5 εκ. χρόνια. Οι επιστήμονες πιστεύουν ότι είχε ένα κέλυφος με χρωματισμό που λειτουργούσε ως καμουφλάζ (αναπαράσταση: Jorge Gonzalez).

Το νέο αυτό είδος είναι μια νεροχελώνα που ζούσε στις λίμνες και τους ποταμούς εκείνης της εποχής και είναι συγγενής της νεροχελώνας *Mauremys caspica* που ζει μέχρι σήμερα στην Ελλάδα. Το νέο είδος, όμως, είχε σημαντικές διαφορές από το σημερινό στη μορφολογία του θυρεού (κέλυφος), και ιδιαίτερα στο σημαντικά μεγαλύτερο πλάτος των κεντρικών κεράτινων πλακών από το αντίστοιχο των σημερινών αντιπροσώπων αυτού του κλάδου. Οι επιστήμονες πιστεύουν ότι με αυτόν τον τρόπο, αυτή η χελώνα μπορούσε να διατηρήσει για μεγαλύτερο χρονικό διάστημα τη χρωματική διακόσμηση του θυρεού που εμφανίζουν τα νεαρά άτομα αυτού του κλάδου. Αντίθετα, οι ενήλικες χελώνες χάνουν αυτή τη διακόσμηση. Άρα, οι χελώνες αυτές είχαν προστασία (καμουφλάζ) για μεγαλύτερο διάστημα της ζωής της και επομένως θα μπορούσαν να έχουν μεγαλύτερες πιθανότητες επιβίωσης.

Παρόμοια μορφολογία είναι γνωστή και σε άλλους κλάδους χελωνών, που είναι γνωστοί από απολιθώματα, οι οποίες θεωρούνταν μέχρι σήμερα ως αντιπρόσωποι διαφόρων κλάδων, συγγενικών και μη μεταξύ τους. Με άλλα λόγια, οι παλαιοντολόγοι πίστευαν ότι παρόμοιου πλάτους κεντρικές κεράτινες πλάκες είχαν εμφανιστεί πολλές φορές ανεξάρτητα μεταξύ τους στην εξελικτική ιστορία των νεροχελωνών. Οι νέες αναλύσεις όμως δείχνουν ότι είναι περισσότερο πιθανό όλες αυτές οι χελώνες με πλατιές κεντρικές πλάκες να ήταν πιο συγγενικές μεταξύ τους, κάτι όμως που εισάγει σημαντικές αλλαγές στη θεώρηση της εξελικτικής ιστορίας και στην ταξινόμηση αυτών των ειδών.

Η νεροχελώνα η αριστοτελική χαρακτηρίζεται από μια σειρά πλατιών κεντρικών κεράτινων πλακών. Τα νέα στοιχεία δείχνουν ότι τα διάφορα είδη της Ευρώπης που ζούσαν εκείνη την εποχή με παρόμοιες κεντρικές πλάκες είχαν στενή συγγένεια μεταξύ τους (αναπαράσταση: Jorge Gonzalez).

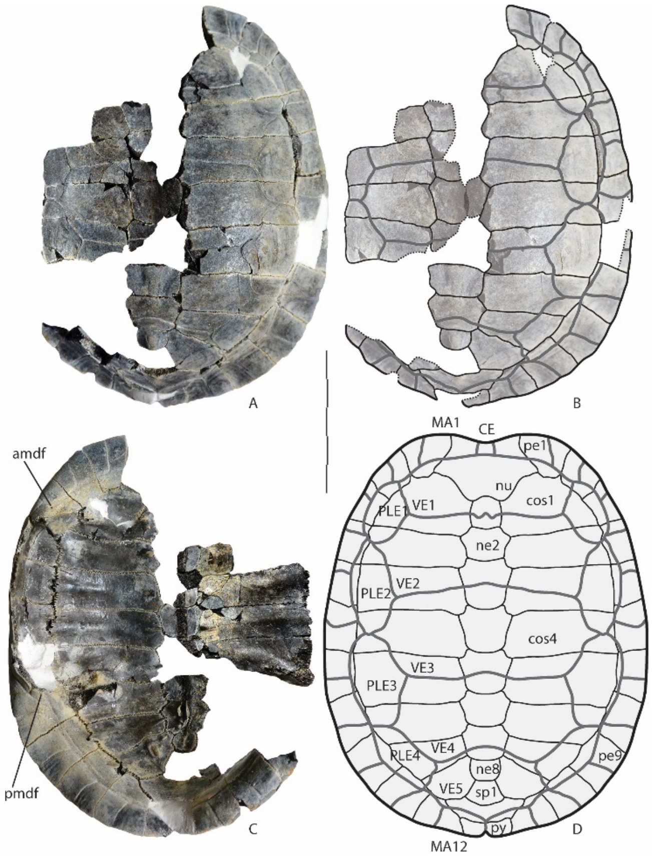
Οι επιστήμονες ονόμασαν το νέο είδος *Mauremys aristotelica*, προς τιμήν του Αριστοτέλη, τα έργα του οποίου αποτελούν τη βάση πολλών επιστημών. Στο βιβλίο του «Περί πορείας ζώων», ο Αριστοτέλης γράφει για πρώτη φορά στην επιστημονική βιβλιογραφία περί «[...] *ἐμύδες τε καὶ χελῶναι* [...]», κάνοντας τον διαχωρισμό ανάμεσα σε υδρόβιες και χερσαίες χελώνες. Οι ονομασίες αυτές, στη συνέχεια, άρχισαν να χρησιμοποιούνται από Λατίνους συγγραφείς (όπως ο Πλίνιος) και έκτοτε έχουν χρησιμοποιηθεί ατόφιες ή σε συνδυασμό στη συντριπτική πλειοψηφία των επιστημονικών λατινικών ονομάτων ειδών, γενών και άλλων ταξινομικών ομάδων χελωνών. Με την ονομασία αυτού του νέου είδους, οι επιστήμονες θέλουν να δώσουν έμφαση στη συνεισφορά και την παγκόσμια απήχηση του έργου του Αριστοτέλη. Επίσης επιθυμούν να τιμήσουν το Αριστοτέλειο Πανεπιστήμιο Θεσσαλονίκης (ΑΠΘ), τον οργανισμό που στήριξε και στηρίζει, μέσω του Τμήματος Γεωλογίας, τις έρευνες των παλαιοντολόγων και προάγει την ελληνική παλαιοντολογία στην Ελλάδα και το εξωτερικό.

Το νέο είδος είναι γνωστό μέσα από μια πληθώρα δειγμάτων του θυρεού, τα οποία έχουν ανακαλυφθεί σε τρεις θέσεις στην ευρύτερη περιοχή της Θεσσαλονίκης, τη Γέφυρα, τα Νέα Σίλατα και το Αλλατίνι. Στην εργασία αυτή, που δημοσιεύτηκε στο επιστημονικό περιοδικό Papers in Palaeontology, έλαβαν μέρος παλαιοντολόγοι από το Museo Paleontológico Egidio Feruglio (Trelew, Chubut, Patagonia, Argentina), το Τμήμα Γεωλογίας του Αριστοτελείου Πανεπιστημίου Θεσσαλονίκης και το Μουσείο Φυσικής Ιστορίας του Απολιθωμένου Δάσους Λέσβου.

Πηγή

Vlachos Evangelos, Sterli Juliana, Vasileiadou Katerina, Syrides George (2018). A new species of *Mauremys* (Testudines: Geoemydidae) from the late Miocene – Pliocene of

Central Macedonia (N. Greece) with exceptionally wide vertebral scutes. Papers in Palaeontology.

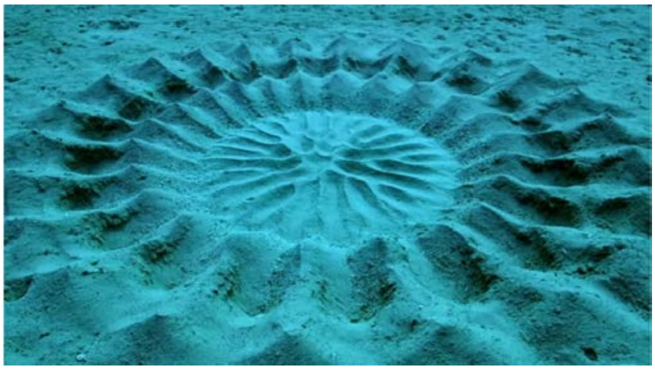


Ένα από τα απολιθώματα της Νεροχελώνας της αριστοτελικής, ο σχεδόν ολόκληρος ραχιαίος θυρεός από το Πλειόκαινο της Γέφυρας στη λεκάνη του Αξιού.

Πληροφορίες – Επικοινωνία

Vlachos Evangelos, CONICET and Museo Paleontológico Egidio Feruglio, Trelew, Chubut, Patagonia, Argentina - evlacho@mef.org.ar

Puffer Fish Creates This Blue Water Art

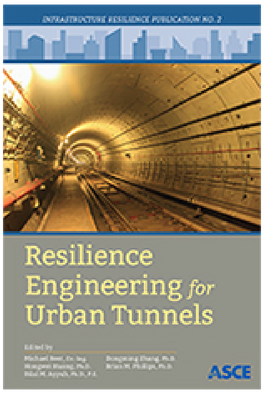


"This video is for educational purposes"! Quick example of the beauty we can find in those BBC-Earth new documentaries. The amazing little puffer fish capable of creating elaborately designed 'crop circles' at the bottom of the ocean as part of an elaborate mating ritual. The behavior was first documented by a photographer named Yoji Ookata who later returned with a film crew from the Japanese nature show NHK which later aired an episode about the fish. Even as articles bounced around the web it was still difficult to imagine how a tiny fish could create such a large design in the sand, even when staring directly at photographic evidence. Finally, video has emerged that shows just how the little guy delicately traverses the sand in a rotating criss-cross pattern to create a sort of subaquatic spirograph. The textured sand sculpture not only attracts mates but also serves as protection when the fish pair and lays eggs.

https://www.youtube.com/watch?v=B91tozyQs9M&feature=youtu.be

Δημοσιεύτηκε στις 3 Απρ 2017.

ΝΕΕΣ ΕΚΔΟΣΕΙΣ ΣΤΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΠΙΣΤΗΜΕΣ



Resilience Engineering for Urban Tunnels

Edited by M. Beer, H. Huang, B. M. Ayyub, D. Zhang, and B. M. Phillips

Infrastructure Resilience Publications (IRP) IRP 2

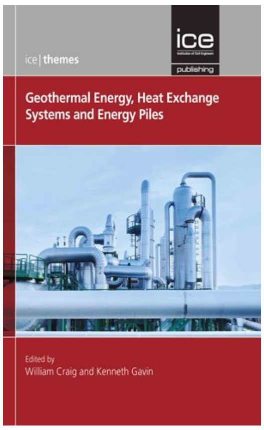
Selected papers from the 2016 International Workshop on Resilience of Urban Tunnels, held in Reston, Virginia, September 1, 2016. Sponsored by the Infrastructure Resilience Division of ASCE.

Resilience Engineering for Urban Tunnels addresses tunnels as a part of the complex urban infrastructure system including transportation systems, such as metro transit networks, and provides a basis for the development of a dynamic risk control and resilient design approach to urban tunnels.

Topics in this, the second Infrastructure Resilience Publication (IRP), include smart sensing, uncertainty modeling in construction, integrated robust design through modularity and adaptability, modeling with a component scale and a systems scale perspective, resilience-informed decision making, and multisector interdependencies. Also included is a report on the discussions held during the workshop and the conclusions drawn for future research recommendations.

IRP 2 provides state of the art information to researchers, practitioners, and students interested in resilience of urban tunnels and infrastructure.

(ASCE, 2018)



Geothermal Energy, Heat Exchange Systems and Energy Piles (ICE Themes)

Edited by William Craig and Kenneth Gavin

The ICE Themes series showcases cutting edge research and practical guidance in all branches of civil engineering. Each title focuses on a key issue or challenge in civil engineering, and includes research from the industry's finest thinkers and influencers published through the ICE Publishing programme. Themes in the series include climate change resilience, advances in construction management, developments in renewable energy, and innovations in construction materials plus many more.

Geothermal Energy, Heat Exchange Systems and Energy Piles (ICE Themes) focuses on topics from high temperature geothermal energy extraction, to lower temperature situations at ground surface and shallow depths. Providing broad international coverage, the chapters encompass field observations on sites in several countries as well as computational and laboratory studies. Ground conditions vary from hard rock to chalk, loess to London Clay.

Key features of this book include:

- international case histories on geothermal energy extraction
- coverage of geothermal resource exploration, characterisation and evaluation
- design and assessment of energy piles.

This book, which has been edited by two leading experts in the field, is an ideal resource for engineers and researchers seeking an overview of the latest research in this exciting area.

(ICE, 05 July 2018)

Γεωτεχνική Μηχανική των Φραγμάτων

Κωνσταντίνος Σαχπάζης

Το νέο αυτό βιβλίο απευθύνεται τόσο σε ενεργούς επαγγελματίες Πολιτικούς Μηχανικούς, Γεωλόγους & Περιβαλλοντολόγους, όσο και στους αντίστοιχους Φοιτητές.

Το βιβλίο εξασφαλίζει με κατανοητό και μεθοδικό τρόπο την μεθοδολογία επιλογής, ανάλυσης, μελέτης και κατασκευής όλων των τύπων των Φραγμάτων εστιάζοντας κυρίως στα θέματα της Γεωτεχνικής Μηχανικής. Ο συγγραφέας του βιβλίου, Κώστας Σαχπάζης, είναι Καθηγητής στην Γεωτεχνική Μηχανική και μελετητής Δημόσιων και Ιδιωτικών Έργων από το 1989, έχοντας μελετήσει πολλές εκατοντάδες έργων μεταξύ των οποίων και μεγάλα φράγματα στην Ελλάδα και στο εξωτερικό.

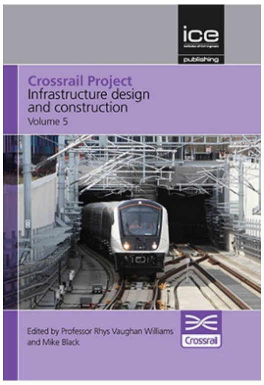
Μεταξύ άλλων, το βιβλίο καλύπτει την ακόλουθη θεματολογία:

- Γενικά – Εισαγωγή περί φραγμάτων,
- Φόρτιση και συντελεστής ασφάλειας,
- Γεωτεχνική διερεύνηση υπεδάφους (Geotechnical site investigation),
- Γεωλογικές – γεωτεχνικές συνθήκες υπεδάφους,
- Υδρολογία,
- Θεμελίωση των φραγμάτων,
- Φράγματα από σκυρόδεμα,
- Φράγματα Αναχωματικού τύπου,
- Υπερχειλιστές, και
- Κατασκευή φραγμάτων.

Γίνεται επίσης αναφορά σε πρανή αναχωμάτων των φραγμάτων σχετικά με την ευστάθεια πρανών, την προσομοίωση κατασκευής και πλήρωσης χωμάτινου φράγματος, κ.ά.). Στο Παράρτημα του βιβλίου παραθέτονται Ερωτήσεις – Ασκήσεις, και παρέχεται εκτενέστατη Βιβλιογραφία.

Επιπλέον στο Παράρτημα δίδεται και το μοναδικό στην Ελλάδα γλωσσάριο (ορολογία) ειδικών όρων και φράσεων που αναφέρονται κυρίως στα φράγματα, και είναι ταξινομημένο αλφαβητικά με βάση τους όρους στα Ελληνικά, αλλά και με βάση τους όρους στα Αγγλικά. Τέλος, παρουσιάζεται το νέο Φ.Ε.Κ. 4420/30 της Δεκεμβρίου 2016, Τεύχος Β, που αφορά την «Έγκριση Κανονισμού Ασφάλειας Φραγμάτων – Διοικητική Αρχή Φραγμάτων»

(Εκδόσεις ΤΣΑΠΡΑΪΛΗ ΧΡΥΣΑΝΘΗ, 2018)



Crossrail Project: Infrastructure Design and Construction - Volume 5

Crossrail, Rhys Vaughan Williams and Mike Black

The construction of the Crossrail project began at North Dock in Canary Wharf in May 2009 and it has been one of the largest single infrastructure investments undertaken in the UK to date. Consisting of 21 kilometres of new twin-bore tunnels and 10 new world-class stations in central London connecting to upgraded lines, the line will provide essential new services to the east and west of the UK capital.

Crossrail Project: Infrastructure Design and Construction - Volume 5 contains 21 new papers submitted to Crossrail's Technical Papers Competition. Contributions have come from consultants, contractors, suppliers and third-party stakeholders all of whom have been involved in the Crossrail project. The papers cover a variety of disciplines including fire safety, sustainability, engineering design, reliability and many more.

As part of the legacy of the Crossrail project, it is important for the organisation to share its experiences and best practices with the rest of the industry and to showcase the skills of the personnel involved and the successful delivery of each phase of works. This fifth volume continues Crossrail's dissemination of that experience as the project itself nears completion with the official launch due in 2018.

Crossrail Project: Infrastructure Design and Construction – Volume 5 offers a valuable source of reference for current practices in design and construction of large-scale underground projects.

(ICE Publishing, 31 August 2018)

ΗΛΕΚΤΡΟΝΙΚΑ ΠΕΡΙΟΔΙΚΑ

www.isrm.net/adm/newsletter/ver_html.php?id_newsletter=157

Κυκλοφόρησε το Τεύχος No. 43 (Σεπτεμβρίου 2018) του Newsletter της International Society for Rock Mechanics and Rock Engineering με τα παρακάτω περιεχόμενα:

- ARMS10 - Register now!
- 23rd ISRM Online Lecture by Prof. Maurice Dusseault
- FedIGS Board meeting in San Francisco
- ISRM 14th International Congress on Rock Mechanics, Foz de Iguaçu, Brazil, September 2019
- AUSROCK 2018, 28-30 November, Sydney, Australia - an ISRM Specialized Conference
- New videos of ISRM Suggested Methods on the ISRM website
- ISRM Rocha Medal 2020 - nominations to be received by 31 December 2018
- New commission on Coupled THMC Processes in Fractured Rock has been nominated
- ISRM Sponsored meetings
- Geotechnical challenges in karst, Omis-Split, 11-13 April 2019, an ISRM Specialised Conference
- The 2019 Rock Dynamics Summit in Okinawa, 7-11 May, an ISRM Specialized Conference
- 3rd ICITG, Guimaães, Portugal, 29 Sep. to 2 Oct. 2019 – September Update
- YSRM2019 and REIF2019, Okinawa, Japan, 1-4 December, an ISRM Specialized Conference

☙ ❧

www.geosyntheticssociety.org/wp-content/uploads/2018/08/IGS-News-Vol34-Issue2.pdf

Κυκλοφόρησε το Τεύχος 2 του Τόμου 34 του Newsletter της International Geosynthetics Society με τα παρακάτω περιεχόμενα:

ΕΚΤΕΛΕΣΤΙΚΗ ΕΠΙΤΡΟΠΗ ΕΕΕΕΓΜ (2015 – 2018)

ΕΕΕΕΓΜ

Τομέας Γεωτεχνικής
ΣΧΟΛΗ ΠΟΛΙΤΙΚΩΝ ΜΗΧΑΝΙΚΩΝ
ΕΘΝΙΚΟΥ ΜΕΤΣΟΒΙΟΥ ΠΟΛΥΤΕΧΝΕΙΟΥ
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«ΤΑ ΝΕΑ ΤΗΣ ΕΕΕΕΓΜ» «αναρτώνται» και στην ιστοσελίδα www.hssmge.gr