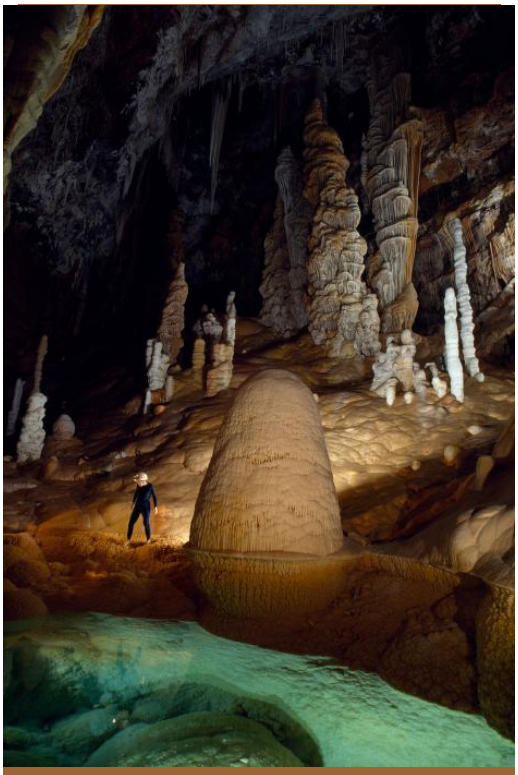

New Mexico's Carlsbad Caverns National Park

ΕΛΛΗΝΙΚΗ
ΕΠΙΣΤΗΜΟΝΙΚΗ
ΕΤΑΙΡΕΙΑ
ΕΔΑΦΟΜΗΧΑΝΙΚΗΣ
& ΓΕΩΤΕΧΝΙΚΗΣ
ΜΗΧΑΝΙΚΗΣ

Τα Νέα της Ε Ε Ε Ε Γ Μ

111

Αρ. 111 – ΦΕΒΡΟΥΑΡΙΟΣ 2018

How sustainable and resilient is geotechnical engineering?

Geotechnical engineers need to focus more on the sustainability and resilience of their solutions. Jeffrey Keaton, editor of an ICE journal on the topic, says simply providing good engineering is no longer enough.

Given the opportunity for casual discussion among geotechnical practitioners and academics, perhaps at a monthly professional society meeting, I would find an opportunity to ask, 'Can you tell me something about the sustainability aspects of your part of the geotechnical design project?'

A common response would be, 'Hmmm…', while the head is in a slow, side-to-side negative shaking motion. 'Nothing on my project has anything to do with sustainability.' My reply might be, 'Really? Are you able to balance cut and fill volumes for your road alignment?' The typical response would be, 'Of course cut and fill volumes are balanced. That's just good engineering.'

The reality is that opportunities for engineering sustainability are everywhere in geotechnical engineering and make themselves available every day. Improved

(συνέχεια στην σελίδα 3)

Π Ε Ρ Ι Ε Χ Ο Μ Ε Ν Α

Gobustan Preserve is one of the highest concentrations of gas-fueled mud volcanoes on Earth, Azerbaijan

Gobustan Preserve, site of rock art dating back 40,000 years, Azerbaijan

Yanardag, a gas poked hill, has been burning for several hundred years, Azerbaijan

(συνέχεια από την πρώτη σελίδα)

awareness among geotechnical engineers of touchpoints in the triple bottom line of economic, environmental and equitable sustainability in simple, low-budget projects – without the fanfare of a state-of-the-art wastewater treatment facility or a formal environmental process – will do a lot for advancing engineering sustainability.

Geotechnical engineering solutions need to be sustainable and resilient, not just 'good'

Defining sustainability and resilience

Sustainable options can be mundane as well as magnificent. Sustainable solutions that were dismissed as nothing but 'good engineering' slowed down the progression of some geotechnical engineers into a modern era of 'better engineering'. What we call 'sustainable engineering' today is more than just good engineering, but it is less than what good engineering will become in future decades.

Sustainability is recognised as a balanced approach which maintains harmony among the three 'E's – environment, economy and equity – so that the quality of life of current and future generations is not compromised. Resilience, on the other hand, is the ability to withstand and recover from disruptions, particularly sudden shocks.

Sustainability can be implemented effectively at the component, building and community levels. Resilience, however, needs to be implemented at the community level. After all, a high-rise building that survives a major earthquake and remains functionally operational would have to be vacated if the toilets cannot be used because the sanitary sewer system in inoperable.

Helping to understand the concepts

The two concepts are related because resilient systems support sustainable communities by remaining functional or having redundancy. This is particularly important for geotechnical engineering because facilities and geo-structures like tunnels, dams and retaining structures that may not be able to return to functionality after disruptions, such as earthquakes or bomb blasts, would not support sustainable communities even if they were constructed with a balance among the three 'E's.

To help geotechnical engineers understand the concepts, ICE has commissioned two themed issues of its *Engineering Sustainability* journal on the topic of sustainability and resilience in geotechnical engineering. The first issue (171 ES1) addresses resilience and sustainability in the management of landslides (Flentje and Chowdhury, 2018), slope stabilisation (Das et al., 2018), stability analyses for slope design (Shepheard et al., 2018) and stabilising coastal slopes (Mickovski and Thomson, 2018).

The papers all describe 'good engineering', while demonstrating that geotechnical engineers contribute to sustainability and community resilience.

February 2018

ΑΡΘΡΑ

Rock Engineering as a Creator of Value

T R Stacey
University of the Witwatersrand, South Africa
INVITED LECTURE

1. INTRODUCTION

Value creation in a mining operation is a long term requirement that demands careful strategic consideration. Unfortunately, cost cutting is a common "fix" to improve financial performance in the short term. Such short term measures may have negative long term consequences. Direct and indirect consequences can include clean-up costs, removal of failed material, excavation rehabilitation, provision of re-access, redployment of personnel and equipment, ore dilution, loss of ore reserves, damage to equipment and infrastructure, reduced life of mine, and costs of loss of production; and direct and indirect costs associated with injuries and fatalities, including disruption of production due to mine stoppages. All consequences need to be taken into account in design, since they destroy value. Rock engineering is important with regard to safety, but often suffers in cost cutting measures, since it is perceived to be a cost, and an inhibitor of, rather than a contributor to, production. Evaluation of such measures could be gained by adopting risk as a rock engineering design criterion (Stacey et al, 2007), and perhaps value created could be used as an even more specific design criterion. In this paper, results of rock engineering research by students under my supervision are presented, which demonstrate substantial value that has resulted from their research.

2. PRECONDITIONING IN GOLD MINE STOPES

In-mine trials in the 1950s indicated the potential of preconditioning to reduce rockbursts in South African gold mines, demonstrating a 73% reduction in severe rockbursts (Toper et al, 2000). However, only after further research did preconditioning become a routine operation in the late 1990s. In this research, Toper (2003) investigated face-perpendicular preconditioning in narrow tabular gold mine stopes, and the associated blasting requirements. The research demonstrated considerable safety benefits, and, despite concerns regarding direct and labour costs, it was found that, with preconditioning, the drilling penetration rate for blast holes was increased; the face advance per blast increased by up to 50%; the condition and stability of the hangingwall was improved; and fragmentation was finer, resulting in more efficient material handling. The benefits are shown in Tables 1 and 2.

"... it can be seen that less time is actually spent drilling in preconditioned panels, despite drilling more metres." And, "This improved fragmentation ... results in about 30% smaller particles and a more uniform particle size distribution, thus improving material handling efficiency." (Toper et al, 2000) The research proved that preconditioning improves safety, productivity and profit, creating value of many millions of dollars during the mine life.

3. OPEN PIT BLASTING, FRAGMENTATION, AND SLOPE DESIGN

Blasting quality determines the damage experienced by the rock mass, and consequently influences the steepness at which open pit mine slopes can be designed. Blasting also determines rock fragmentation, which influences the efficiency of loading, hauling and milling. At the Potgietersrus Open Pit Platinum Mine, Bye (2003) conducted 240 trial blasts and measured resulting fragmentation. Optimum blast designs to produce required fragmentations resulted from this research. Bye (2005b) subsequently extended his research to include the use of electronic delay detonators (EDDs), an extra cost, but it was found that fragmentation achieved exceeded requirements, and therefore blast patterns were expanded, achieving a cost benefit. The success of the blast design research is illustrated by the following quote and the results shown in Figure 1.

Table 1: Comparative drilling rates in adjacent pre-at

Stope scenario (blast hole length and diameter)	Minimum time	Average time	Maximum time	Average (m/min)
Unpreconditioned	4'34"	5'08"	5'51"	0.21
Preconditioned (2.4m, 36mm)	3'56"	4'48"	5'50"	0.23
Preconditioned (3.2m, 36mm)	3'00"	3'57"	5'10"	0.28
Preconditioned (3.8m, 36mm)	2'30"	3'05"	3'55"	0.36
Preconditioned (3.2m, 40mm)	1'56"	3'14"	4'31"	0.34

Table 2: Comparative face advance rates (after Toper et al, 2000)

Stope scenario (blast hole length and diameter)	Minimum (m/blast)	Average (m/blast)	Maximum (m/blast)
Unpreconditioned	0.55	0.70	0.85
Preconditioned (2.4m, 36mm)	0.80	1.06	1.60
Preconditioned (3.2m, 36mm)	0.80	1.16	1.50
Preconditioned (3.8m, 36mm)	0.90	1.14	1.35
Preconditioned (3.2m, 40mm)	0.90	1.03	1.20

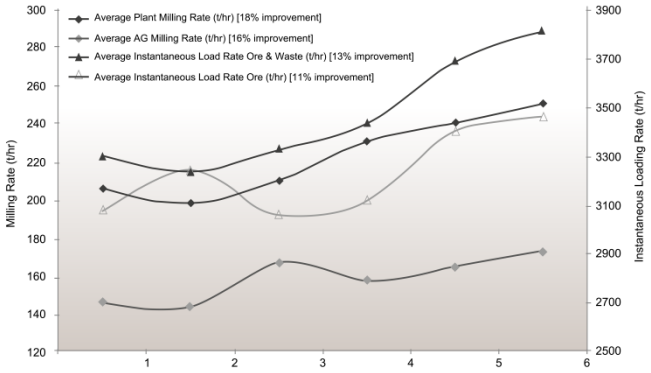

Fig. 1 - Loading and milling performance improvement (after Bye, 2003)

"The results show that the model adds value to the Mine to Mill process by dramatically improving loading efficiencies and milling rates by up to 18%. Additional revenue of over $2 million a month is realised in the plant alone." (Little et al, 2007).

Bye's (2003) research also dealt with open pit slope design, slope stability evaluation, slope optimization, slope monitoring and slope management. Slope design requires geotechnical information on rock types and their properties, and on geological structures and their properties, as well as information on groundwater conditions, in situ stresses, and the geometry of the orebody, which dictates the geometry of the pit. Bye (2003, 2005a) developed a 3D geotechnical block model of the mine to contain the relevant data col-

lected. This model consisted of 15m^3 blocks that contained interpolated geotechnical information: rock type, uniaxial compressive strength, RQD, Laubscher's Mining Rock Mass Rating. The data were geostatistically interpolated between borehole and face map (considered as horizontal boreholes) information. The block model was used to predict blasting costs, making use of Lilly's (1986) blastability index and modified Cunningham (1986) fragmentation equation. A function was also developed in the block model to estimate inter-ramp slope angles using the Haines and Terbrugge (1991) approach. This quickly indicated where planned slopes could be steepened and, conversely, when they were too steep. Detailed stability analyses allowed steepening of the overall pit slopes. "The development of the slope design model provided the opportunity to move away from one design process for the entire pit and customization of slope design and configurations were developed to cater for local variations in the rock mass conditions. The availability of the geotechnical information in 3D and the improved level of confidence of that data resulted in a slope optimization of the final pit. By undertaking numerical modelling based on the enhanced geotechnical database the final walls were optimized by three degrees, resulting in revenue increase for the mine in excess of ZAR900 million [currently about $60 million]. The slope optimization was linked to a risk-reward design approach, which was made possible by the confidence in the geotechnical information used for the design options." (Bye, 2003).

4. GEOTECHNICAL DATA, DATABASING AND ITS USE IN OPEN PIT SLOPE DESIGN AND MANAGEMENT

Little (2006a) made a significant contribution to Bye's (2003) research. The scope of her research covered the full range of data collection, validation, storage, use in slope design, and slope optimization and management. Her contribution is best recognized in the databasing work carried out (Little, 2006b). Activities over a three year period during the research included 220 km of exploration drilling, mapping of 1000 km of rock face, and more than 7000 laboratory and field tests. This produced a substantial amount of geotechnical data, and, to manage this, geotechnical databases were developed for borehole core logging and face mapping, with rock testing data incorporated into both. The existing groundwater and slope monitoring database was improved. Very importantly, a pit inspections database was developed. Inspections included daily pit inspections, detailed pit inspections, hazard mapping and presplit inspections. The database enabled users to view what inspections were done, where, by whom and on what date. Emails sent to operations managers, when a new inspection was added, allowed them to add comments, and subsequently communicate the observations to their subordinates who implemented the risk mitigation recommendations. This ensured that the information was acted upon immediately and appropriate personnel held accountable. By storing the inspections in a database, the data were secure, auditable, standardised and readily available.

Slope monitoring is an important aspect of slope management at the mine since slope failures developed very quickly, typically giving warning of an hour (Bye et al, 2005). Radar monitoring contributed importantly to safety and slope management. Data from laser and prism monitoring, and from piezometers and crack meters were also databased.

Geotechnical databases ensured that no data were lost, that data could be validated, and that standards were maintained. The availability of quality, ordered information allows for confident analysis and design. Regular updating of data allows for designs to be optimised routinely, reducing the risk of slope failure, and improving the economics and safety of the open pits.

Little's (2006a) research contribution was significant: "The work done in the last four years has resulted in PPRust becoming the benchmark for open pit geotechnics in Anglo American. The challenge is now to stay there." (Little et al, 2007)

5. RESEARCH INTO THE PERFORMANCE OF THIN SPRAY-ON LINERS

Thin spray-on liners (TSLs) are used for the support and stabilization of exposed rock surfaces in mines and other excavations. They are sprayed with thicknesses of only a few milimetres, hence their strength performance is very important. Research carried out by Yilmaz (2011) made a significant contribution towards establishing standard methods for testing such liner materials. Mpunzi (2011) and Masethe (2014) also made contributions regarding TSL performance (Mpunzi et al, 2015). An interesting case study demonstrating value from the use of TSLs was presented by Carstens (2005). This case involved instability and rockfalls in strike gullies in a deep level gold mine. These gullies provide access to the face of the stopes for mine workers, as well as the route along which ore is removed from the stope face area. Owing to restricted access, rockbolt support was difficult and hazardous to install, shotcreting logistically impossible, and the environment was subjected to significant seismic activity, as shown in Figure 2.

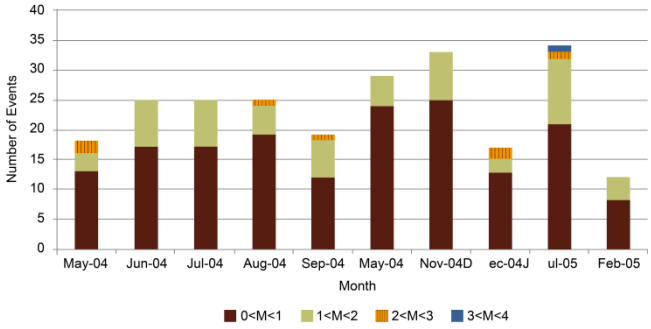

Fig. 2 - Seismicity over a 10 month period (after Carstens, 2005)

The challenges included safety, maintenance of access to the stope face, and reduction of interruptions to production. A TSL, logistically attractive due to portability and limited volumes of material required, was effective in stabilising the gullies, and also under rockburst conditions. A substantial safety improvement was achieved (a major objective) and production disruptions were minimized. There was an additional benefit that had not been anticipated in the choice of TSL support: collapses occurred regularly on the stope face after blasts, and it took about three weeks to rehabilitate the collapse area. Spraying the hangingwall and face area with TSL to seal and support exposed shale rock resulted in rehabilitation within a week. The result was a substantial reduction in loss of production, which, financially, proved to be extremely beneficial. The estimated value resulting to the mine was about 100 times the cost of the TSL used.

6. PROBABILISTIC EVALUATION OF SUPPORT REQUIREMENTS IN NARROW REEF TABULAR STOPES

In deep level tabular reef mining, rockfalls have been a major safety hazard, and research carried out in this area included the work of Rwodzi (2011) and Nezomba (2012). Rwodzi (2011) proposed a generic methodology to quantify the cost of the losses associated with rockfalls, including the costs of accidents. Nezomba (2012) focused on predicting the probability of occurrence of rockfalls in the tabular mining geometry, based on the statistical parameters of the jointing in the rock mass. Nezomba (2012) showed that the probability of failure of blocks greater than a certain size can be predicted very satisfactorily, as shown in Figure 3.

Clamping stresses assumed in the hangingwall can be used as a means of "calibrating" the curves.

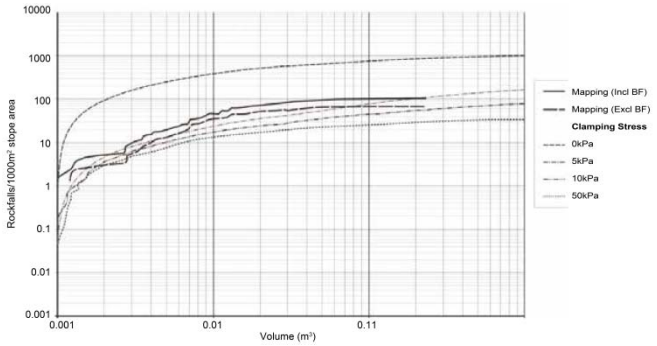

Fig. 3 - Mapped rockfall volume distributions on the Merensky reef, and predicted distributions (including and excluding blast fractures, BF) (after Nezomba, 2012)

The probable locations of rockfalls can also be determined, allowing the probability of occurrence of an accident to be calculated, as well as the total costs of the consequences of rockfalls and collapses (Rwodzi, 2011). Consequential costs include direct and indirect costs associated with accidents, rehabilitation, damage to equipment, loss of production, loss of reserves, reassignment of the workforce, dilution of ore, etc. Regarding the creation of value, an example of the quantification of the relative performances of alternative types of stope support was described by Rwodzi et al (2011): statistical data for six joint sets in the rock mass were used in the probabilistic prediction of rockfall volumes and locations of falls for alternative support types. The results showed that, for a low cost support type, the predicted rockfall failure volume per 1000 m^2 of stope hangingwall exposed was 122 m^3. For a higher cost support type, the corresponding volume was only 53 m^3. The overall direct and indirect costs associated with the lower cost support type were approximately \$1.2 million per panel, and about \$0.5 million for the higher cost support type. Therefore, the use of the higher cost support system would create value for the mine of some \$0.7 million per panel, as well as providing better safety.

Further research into this probabilistic approach resulted in a risk evaluation model for tabular mining support design in the Bushveld Complex (Joughin et al, 2012a; 2012b).

7. THE BENEFIT OF "ACCURATE" DESIGN OF OPEN STOPES

In mines using an open stoping mining method, dilution often has a significant effect on profitability. At Target Mine in South Africa (Le Roux, 2015), it was found that, in some open stopes, dilution was in excess of 10%, falls of ground being a major contributor to the problem. Dilution has resulted in a reduction of the recovered gold grade from 5.5 to 4.5g/t, corresponding with a potential loss of about \$1.5 million per month. In addition to the cost of dilution, the cost of damage to, or loss of, trackless equipment due to falls of ground in open stopes, is very significant, as shown in Figures 4 and 5. A review of financial figures has shown that, over the past 10 years at the mine, this cost could have been as high as \$35 million.

In addition, falls of ground lead to standing time for 15 mechanised equipment, with associated costs. Other associated costs for transport, hoisting, secondary blasting, milling and plant treatment total about \$20 million, and the total opportunity loss over the past 10 years at the mine is estimated to have been \$55 million. These costs demonstrate the importance of the design of stable open stopes to reduce the falls of ground.

Research into the stope instability at Target Mine (Le Roux, 2015) indicated that conventional rock mass failure criteria were unsuitable for stope design at the mine. An alternative strain-based design criterion was developed, which proved to be very successful, allowing the stability of open stopes to be determined reliably. After its implementation in 2010, major reductions in dilution (see Figure 6) and equipment damage have resulted, creating value for the mine.

Fig. 4 - Mechanised equipment damage by rock falls in open stopes (after Le Roux, 2015)

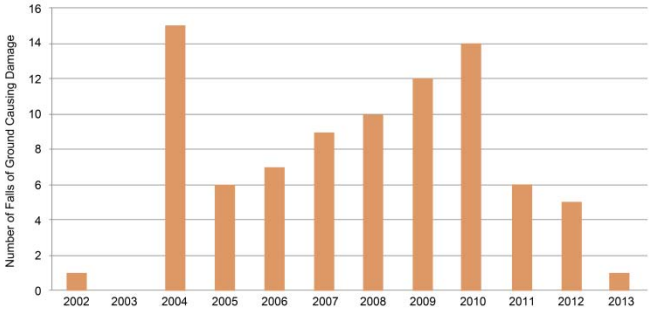

Fig. 5 - Falls of ground causing damage to mechanised equipment (after Le Roux,2015)

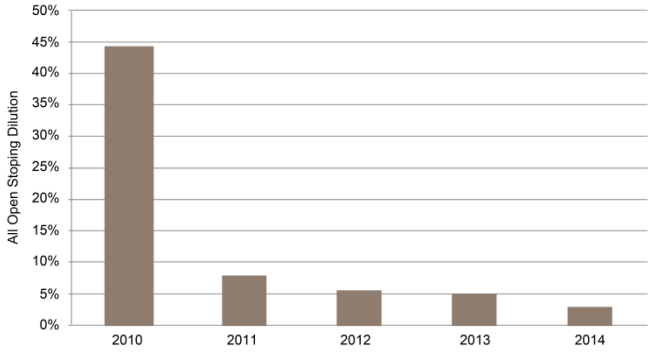

Fig. 6 - Total dilution per year on Target Mine (after Le Roux, 2015)

Based on Life of Mine projections prior to the introduction of the new design criterion, the total potential loss of income could have exceeded \$210 million, clearly illustrating the value contributed by this rock engineering research.

8. DISCUSSION AND CONCLUSIONS

Appropriate rock engineering research can make a significant contribution to value in the mining industry: the examples of rock engineering research described have demonstrated value creation totalling some \$0.5 billion. Mine design and operating decisions are usually based on technical criteria, which are necessary to enable the appropriate calculations to be carried out to facilitate engineering decision

making. Mining executives would commonly be unaware of the detail involved in these decisions. The examples described above suggest that an additional criterion should be applied to any significant design and operational decision, which would be a criterion specific to mining executives. The following is suggested: "What is the value created in the short, medium and long term by the design or proposed operational change, and am I satisfied with this value?" Such a "value" criterion would allow mining executives to be fully involved in, and take responsibility for, important decision-making, and ensure that there is creation of value in the appropriate time frame. A key aspect of such a value creation criterion is that consequences of decisions are quantified in financial terms. These include direct consequences and, particularly importantly, indirect consequences. Executives should demand full details of all consequential costs from their technical, financial and management staff so that they can make informed decisions for their company.

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I became the supervisor for Alan Bye and for Zafer Toper when their research was well progressed. The other students referred to, carried out their full research under my supervision at the University of the Witwatersrand.

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(ISRM News Journal, Volume 20, December 2017, pp. 61-67,
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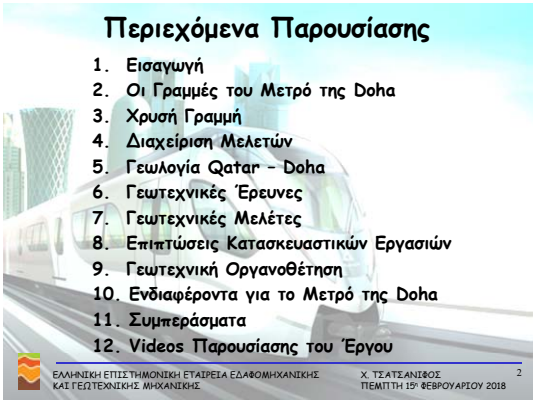
ΝΕΑ ΑΠΟ ΕΛΛΗΝΙΚΕΣ ΚΑΙ ΔΙΕΘΝΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΝΩΣΕΙΣ

ΕΛΛΗΝΙΚΗ ΕΠΙΣΤΗΜΟΝΙΚΗ ΕΤΑΙΡΕΙΑ ΕΔΑΦΟΜΗΧΑΝΙΚΗΣ & ΓΕΩΤΕΧΝΙΚΗΣ ΜΗΧΑΝΙΚΗΣ

Διάλεξη Χρήστου Τσατσανίφου
Μετρό Doha: Mega Project με ρεκόρ Guinness

Την Πέμπτη 15 Φεβρουαρίου 2018 ο συνάδελφος Χρήστος Τσατσανίφος, Εκδότης των ΝΕΩΝ ΤΗΣ ΕΕΕΕΓΜ και τέως Πρόεδρο της Εκτελεστικής Επιτροπής.

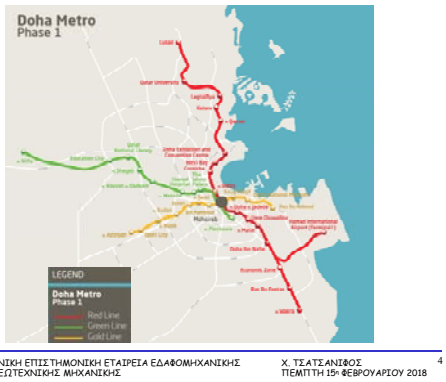
Στην διάλεξη προβλήθηκαν τα γεωτεχνικά, κυρίως, θέματα, που παρουσιάσθηκαν κατά την διάρκεια της κατασκευής του έργου, οι τρόποι και μέθοδοι αντιμετώπισής τους, καθώς και ο τρόπος διαχείρισης των μελετών του έργου. Στην συνέχεια παρουσιάζονται κάποια αποσπάσματα από την παρουσίαση της διάλεξης.



Το Μετρό της Doha είναι ένα από τα πλέον προβεβλημένα έργα του Qatar. Θα εξυπηρετήση τόσο την πρωτεύουσα της χώρας όσο και τα προάστιά της, με όλες τις σημαντικές τοποθεσίες να έχουν εύκολη και άνετη πρόσβαση σ' αυτό.

Το Μετρό της Doha θα κατασκευασθή σε δύο φάσεις: κατά την διάρκεια της πρώτης φάσης θα κατασκευάζονται οι τρεις από τις τέσσερεις συνολικά προβλεπόμενες γραμμές (Κόκκινη, Χρυσή και Πράσινη) με 37 σταθμούς. Αναμένεται ότι η λειτουργία και των τριών γραμμών θα αρχίση το 2019. Η δεύτερη φάση θα ολοκληρωθή το 2026, και θα περιλαμβάνη την επέκταση των ήδη κατασκευασθεισών γραμμών, καθώς και την κατασκευή μιας νέας – της Γαλάζιας Γραμμής. Στην φάση αυτή θα κατασκευασθούν 72 ακόμη σταθμοί.

Η μελέτη και κατασκευή του έργου γίνεται από κοινοπραξίες με εταιρείες προερχόμενες από διάφορες χώρες. Συγκεκριμένα οι κατασκευαστικές κοινοπραξίες συνίστανται από εταιρείες από την Αυστρία, Γαλλία, Ελλάδα, Ισπανία, Ιταλία, Κατάρ, Νότια Κορέα, Σαουδική Αραβία και Τουρκία. Το έργο μελέτησαν εταιρείες από την Γερμανία, Δανία, Ελλάδα, Ηνωμένο Βασίλειο, Ισπανία και Λίβανο.



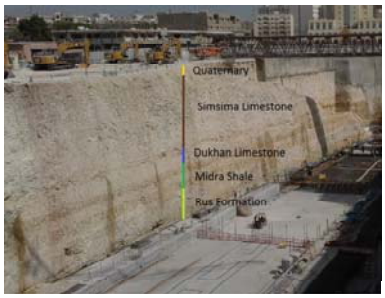
Όλοι οι σταθμοί των υπογείων τμημάτων του ΜΕΤΡΟ κατασκευάστηκαν με την μέθοδο της Εκσκαφής & Επανεπίχωσης. Λαμβάνοντας υπ' όψη ότι η Doha είναι μια σχετικά νέα πόλη (εξαιρουμένου του ιστορικού κέντρου της), δεν υπήρξε, γενικά, πρόβλημα στην εξεύρεση των κατάλληλων χώρων για την κατασκευή των σταθμών. Υπήρξαν, όμως, και περιπτώσεις όπου έγινε απαλλοτρίωση οικοπέδων, με κτίρια εντός αυτών, τα οποία κατεδαφίστηκαν προκειμένης της κατασκευής των σταθμών και άλλων βοηθητικών κτιρίων.

Το όλο έργο κατασκευάζεται με την μέθοδο της Μελέτης και Κατασκευής. Η κάθε κατασκευαστική Κοινοπραξία επέλεξε μελετητή και Ανεξάρτητο Μηχανικό (τον ονομάζουμε DVE - Design Verification Engineer), οι οποίοι εγκρίθηκαν από τον πελάτη (Qatar Rail). Ο DVE ελέγχει λεπτομερώς τις μελέτες και συντάσσει σχετικό έντυπο ελέγχου με παρατηρήσεις και εν τέλει εγκρίνει την μελέτη. Όμως, ο έλεγχος της μελέτης δεν σταματά στον DVE. Έπεται ο έλεγχος από τον Project Management Consultan (PMC), εκπρόσωπο του Κυρίου του Έργου (Qatar Rail) σε κάθε υποέργο, και η διαδικασία ελέγχου κλείνει με τον έλεγχο της μελέτης από το Τεχνικό Τμήμα της Qatar Rail, από το οποίο δίνεται και η τελική έγκριση της μελέτης.

Στο όρυγμα της παρακάτω φωτογραφίας βλέπουμε την λιθολογική αλληλουχία κατά μήκος του μεγαλυτέρου τμήματος των διαδρόμων του METRO, που αποτελείται (από την επιφάνεια του εδάφους προς τα κάτω) από:

- Επιφανειακές αποθέσεις (Τεταρτογενείς και ανθρωπογενείς)
- Ασβεστόλιθος Simsima (του ανώτερου τμήματος του Σχηματισμού Dammam)
- Ασβεστόλιθος Dukhan (του ανώτερου τμήματος του Σχηματισμού Dammam)
- Σχιστόλιθος (shale) Midra (του κατώτερου τμήματος του Σχηματισμού Dammam)
- Το ανθρακικό Μέλος του Σχηματισμού Rus
- Το θειικό Μέλος του Σχηματισμού Rus (γύψοι)

Γεωλογία Qatar – Doha



Το φαινόμενο της καρστικοποίησης παρατηρείται ευρύτατα στην χερσόνησο του Qatar και ήταν ένα από τα κύρια θέματα των γεωλογικών και γεωτεχνικών διερευνήσεων για το έργο. Μεγάλης κλίμακας καρστικά έγκοιλα (σπηλαιώσεις) δεν ευρέθησαν κατά μήκος των διαδρόμων του METRO. Μικρότερα καρστικά έγκοιλα (μέχρι περίπου 2m εύρος) ευρέθησαν σε εκσκαφές για του σταθμούς, όχι όμως πολλά. Μικρής κλίμακας καρστικά έγκοιλα (εύρους < 0.25m) ήταν αρκετά συχνά. Η ύπαρξη των καρστικών εγκοίλων επέβαλε την εκτέλεση γεωφυσικών ερευνών κατά μήκος των σηράγγων, καθώς και κάτω από την στάθμη θεμελίωσης των σταθμών.

Το άλλο κύριο θέμα που μας απασχόλησε ήταν τα υπόγεια νερά και η διαβρωτικότητά τους. Στην περιοχή της Doha παρατηρούμε δύο υδροφορείς:

- Τον "επιφανειακό" υδροφορέα, που αναπτύσσεται εντός του ασβεστολίθου Simsima, και
- Τον "ρηχό" υδροφορέα, που αναπτύσσεται κυρίως εντός των ανθρακικών βραχομαζών του Σχηματισμού Rus.

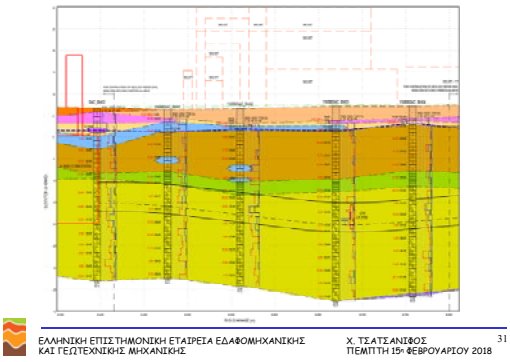
Δεδομένου ότι στις περισσότερες περιπτώσεις ο Σχιστόλιθος Midra δρα στεγανωτικά για την προς τα κάτω κίνηση του επιφανειακού υδροφορέα, η μεγαλύτερη κυκλοφορία νερού συναντάται στην διεπιφάνεια του Ασβεστολίθου Simsima και του Σχιστολίθου Midra. Παρ' όλα αυτά, υπήρξαν περιπτώσεις όπου, λόγω παλαιότερων καρστικών φαινομένων, δεν παρεμβάλετο ο Σχιστόλιθος Midra μεταξύ των δύο υδροφορέων και είχαμε συνένωσή τους, η οποία, σε κάποιες περιπτώσεις, δημιούργησε προβλήματα (πλημμύρισε η σήραγγα!).

Αρχικά υπεβλήθη η **Έκθεση Γεωτεχνικής Εκτίμησης**: Περιείχε δύο μέρη. Στο Πρώτο Μέρος έγινε αξιολόγηση όλης της υπάρχουσας πληροφόρησης, προκειμένου να καταστρωθή το πρόγραμμα των συμπληρωματικών ερευνών. Στο Δεύτερο Μέρος παρουσιάστηκε το πρόγραμμα των συμπληρωματικών ερευνών, το οποίο καταστρώθηκε βάσει των συμβατικών απαιτήσεων και των προδιαγραφών (π.χ. 1 γεώτρηση ανά 100 m σήραγγας ή 6 γεωτρήσεις για κάθε σταθμό κ.λπ.).

Μετά την έγκριση της Έκθεσης Γεωτεχνικής Εκτίμησης εκτελέσθηκαν οι **Συμπληρωματικές Γεωτεχνικές Έρευνες** και τα αποτελέσματά τους υπεβλήθησαν με την **Έκθεση Παρουσίασης Αποτελεσμάτων Γεωτεχνικών Ερευνών**.

Παρομοίως, εκτελέσθηκαν γεωφυσικές έρευνες και τα αποτελέσματά τους υπεβλήθησαν με την **Έκθεση Γεωφυσικών Ερευνών**. Οι γεωφυσικές έρευνες διεξήχθησαν κατά μήκος των σηράγγων και κάτω από την στάθμη θεμελίωσης των κατασκευών Εκσκαφής & Επανεπίχωσης.

Γεωτεχνική Τομή Σχεδιασμού (Σήραγγα)



Τα αποτελέσματα όλων των ερευνών αξιολογήθηκαν με την **Έκθεση Αξιολόγησης Αποτελεσμάτων Ερευνών**, η οποία περιείχε τις τελικές γεωτεχνικές τομές σχεδιασμού, δηλαδή την στρωματογραφία, τις τιμές σχεδιασμού των διαφόρων παραμέτρων για κάθε στρώμα (φυσικές και μηχανικές ιδιότητες), την στάθμη των υπόγειων νερών, την στάθμη θεμελίωσης των έργων και κάθε άλλη πληροφορία σχετική με τα έργα (σήραγγες και σταθμοί).

Οι Γεωτεχνικές Μελέτες αφωρούσαν στην μελέτη αντιστήριξης των πρανών των εκσκαφών για την κατασκευή των σταθμών και των φρεάτων, όλων με την μέθοδο της Εκσκαφής & Επανεπίχωσης, στην μελέτη των σηράγγων κυκλοφορίας των συρμών, που διανοίχθηκαν με TBMs και προκατασκευασμένους δακτυλίους, στην μελέτη των Συνδετήριων Σηράγγων μεταξύ των κυρίων σηράγγων, καθώς και στην μελέτη των Υπογείων Διαβάσεων (σηράγγων). Όλες οι μελέτες αυτές βασίστηκαν στις Γεωτεχνικές Τομές Σχεδιασμού που ανέφερα προηγουμένως.

Οι μελέτες καθώς και η εφαρμογή τους έπρεπε να λάβουν υπ' όψη τους την γειτονία με άλλες κατασκευές του έργου (σήραγγες, σταθμούς κ.λπ.) ή και κατασκευές τρίτων, και την ελαχιστοποίηση των επιπτώσεων επ' αυτών.

Ορύγματα για Σταθμούς και Φρέατα

ΕΛΛΗΝΙΚΗ ΕΠΙΣΤΗΜΟΝΙΚΗ ΕΤΑΙΡΕΙΑ ΕΔΑΦΟΜΗΧΑΝΙΚΗΣ ΚΑΙ ΓΕΩΤΕΧΝΙΚΗΣ ΜΗΧΑΝΙΚΗΣ Χ. ΤΣΑΤΣΑΝΙΦΟΣ ΠΕΜΠΤΗ 15η ΦΕΒΡΟΥΑΡΙΟΥ 2018 35

Ορύγματα για Σταθμούς και Φρέατα

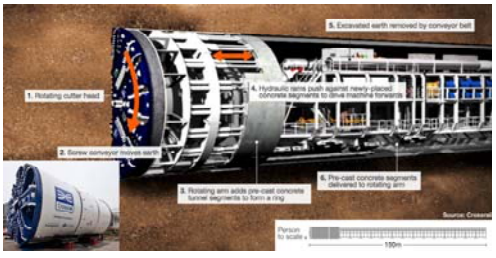
ΕΛΛΗΝΙΚΗ ΕΠΙΣΤΗΜΟΝΙΚΗ ΕΤΑΙΡΕΙΑ ΕΔΑΦΟΜΗΧΑΝΙΚΗΣ ΚΑΙ ΓΕΩΤΕΧΝΙΚΗΣ ΜΗΧΑΝΙΚΗΣ Χ. ΤΣΑΤΣΑΝΙΦΟΣ ΠΕΜΠΤΗ 15η ΦΕΒΡΟΥΑΡΙΟΥ 2018 36

Ορύγματα για Σταθμούς και Φρέατα

ΕΛΛΗΝΙΚΗ ΕΠΙΣΤΗΜΟΝΙΚΗ ΕΤΑΙΡΕΙΑ ΕΔΑΦΟΜΗΧΑΝΙΚΗΣ ΚΑΙ ΓΕΩΤΕΧΝΙΚΗΣ ΜΗΧΑΝΙΚΗΣ Χ. ΤΣΑΤΣΑΝΙΦΟΣ ΠΕΜΠΤΗ 15η ΦΕΒΡΟΥΑΡΙΟΥ 2018 38

Το μεγαλύτερο μέρος των γραμμών του Μετρό της Doha είναι υπόγειο, και ως εκ τούτου η μεθοδολογία κατασκευής σηράγγων έχει σημαντικό ρόλο στην κατασκευή του. Τα υπόγεια τμήματα, που έχουν ήδη κατασκευασθή, διατρήθηκαν με μηχανήματα ολομέτωπης κοπής (TBMs). Αυτό σημαίνει ότι υπήρξε η ελάχιστη δυνατή αναστάτωση στην λειτουργίας της πόλης στην επιφάνεια του εδάφους.

Σήραγγες Κυκλοφορίας Συρμών
Μηχανήματα Ολομέτωπης Κοπής-TBMs



ΕΛΛΗΝΙΚΗ ΕΠΙΣΤΗΜΟΝΙΚΗ ΕΤΑΙΡΕΙΑ ΕΔΑΦΟΜΗΧΑΝΙΚΗΣ ΚΑΙ ΓΕΩΤΕΧΝΙΚΗΣ ΜΗΧΑΝΙΚΗΣ Χ. ΤΣΑΤΣΑΝΙΦΟΣ ΠΕΜΠΤΗ 15η ΦΕΒΡΟΥΑΡΙΟΥ 2018 41

Λόγω της γεωλογικής δομής του Qatar, η Qatar Rail επέλεξε να χρησιμοποιήση μηχανήματα "αντιστάθμισης της πίεσης των γαιών" (Earth Pressure Balance - EPB). Τα μηχανήματα αυτά είναι ιδανικά για συνθήκες μαλακού βράχου και μπορούν να αντιμετωπίσουν ευχερώς τα προβλήματα που δημιουργούν οι υψηλοί υδροφόροι ορίζοντες στο υπέδαφος της Doha.

Σήραγγες
Earth Pressure Balance EPB-TBM

ΕΛΛΗΝΙΚΗ ΕΠΙΣΤΗΜΟΝΙΚΗ ΕΤΑΙΡΕΙΑ ΕΔΑΦΟΜΗΧΑΝΙΚΗΣ ΚΑΙ ΓΕΩΤΕΧΝΙΚΗΣ ΜΗΧΑΝΙΚΗΣ Χ. ΤΣΑΤΣΑΝΙΦΟΣ ΠΕΜΠΤΗ 15η ΦΕΒΡΟΥΑΡΙΟΥ 2018 42

Tunnel Boring Machines

Προετοιμασία TBMs για την διάτρηση

ΕΛΛΗΝΙΚΗ ΕΠΙΣΤΗΜΟΝΙΚΗ ΕΤΑΙΡΕΙΑ ΕΔΑΦΟΜΗΧΑΝΙΚΗΣ ΚΑΙ ΓΕΩΤΕΧΝΙΚΗΣ ΜΗΧΑΝΙΚΗΣ Χ. ΤΣΑΤΣΑΝΙΦΟΣ ΠΕΜΠΤΗ 15η ΦΕΒΡΟΥΑΡΙΟΥ 2018 45

Συνολικά διατρήθηκαν 111 km σηράγγων και χρησιμοποιήθηκαν 470,497 segments. Γιορτάσαμε 72 ξετρυπήματα!

72 «Ξετρυπήματα» TBMs!

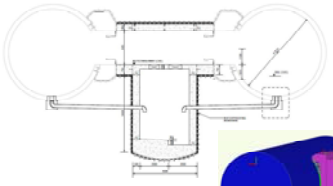
ΕΛΛΗΝΙΚΗ ΕΠΙΣΤΗΜΟΝΙΚΗ ΕΤΑΙΡΕΙΑ ΕΔΑΦΟΜΗΧΑΝΙΚΗΣ ΚΑΙ ΓΕΩΤΕΧΝΙΚΗΣ ΜΗΧΑΝΙΚΗΣ Χ. ΤΣΑΤΣΑΝΙΦΟΣ ΠΕΜΠΤΗ 15η ΦΕΒΡΟΥΑΡΙΟΥ 2018 48

Τα πρώτα TBMs άρχισαν διάτρηση τον Ιούλιο 2014 και την Κυριακή 25 Σεπτεμβρίου 2016 ολοκληρώθηκε η διάτρηση του 111ου χιλιομέτρου των σηράγγων κυκλοφορίας των συρμών, με το ξετρύπημα του TBM "Msheireb" στον Τερματικό Σταθμό 1 του Διεθνούς Αεροδρομίου Hamad.

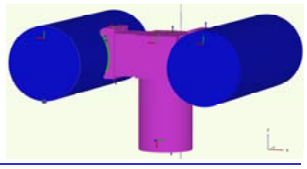
Τα 21 τελευταίας τεχνολογίας TBMs που χρησιμοποίησε η Qatar Rail, σε κάποια χρονική περίοδο ταυτοχρόνως, αναγνωρίσθηκαν από την Guinness World Records ως "The Largest Number of Tunnel Boring Machines Operating Simultaneously on a Single Project".

Οι συνδετήριες σήραγγες κατασκευάστηκαν με την ΝΑΤΜ, ενώ, λόγω της γεωμετρίας στις θέσεις κατασκευής τους, η μελέτη τους έγινε βάσει τρισδιάστατων αναλύσεων πεπερασμένων στοιχείων.

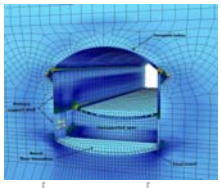
Συνδετήριες Σήραγγες
Μελετήθηκαν και κατασκευάστηκαν με την ΝΑΤΜ



Για την μελέτη τους έγιναν αναλύσεις 3D FEM

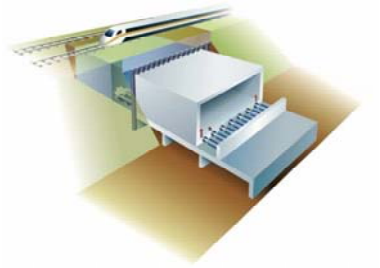


Για την κατασκευή των υπογείων διαβάσεων χρησιμοποιήθηκαν διάφορες μέθοδοι, όπως η απλή ΝΑΤΜ, ΝΑΤΜ με συμβατικές δοκούς προπορείας, ΝΑΤΜ με μεγάλης διαμέτρου δοκούς προπορείας σε όλο το μήκος της διάβασης και η μέθοδος του Jacked Box Tunnelling, που εφαρμόστηκε για πρώτη φορά στην περιοχή για σήραγγες μεγάλης διατομής.



Υπόγειες Διαβάσεις
ΝΑΤΜ με συμβατικές δοκούς προπορείας

Υπόγειες Διαβάσεις
Tunnel Jacking (Jacked Box Tunnelling)



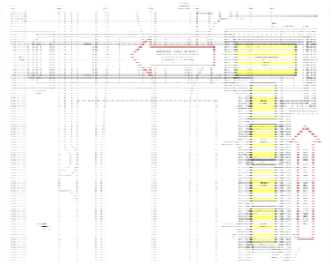
Το Tunnel jacking ή **jacked-box tunneling** χρησιμοποιείται για την κατασκευή διαβάσεων κάτω από λειτουργούσες σιδηροδρομικές γραμμές και οδικές αρτηρίες, σπρώχνοντας ένα κιβώτιο σκυροδέματος μέσα στο έδαφος χρησιμοποιώντας ειδικά μηχανήματα και υδραυλικούς γρύλλους.

Το κιβώτιο, που θα προωθηθή εντός του εδάφους κατασκευάζεται, συνήθως από ωπλισμένο σκυρόδεμα, σε χώρο δίπλα από την θέση προώθησης. Στη συνέχεια μετακινείται στην θέση προώθησης και ωθείται στο έδαφος με διάταξη υποστήριξης των υπερκειμένων πλησίον του μετώπου εκσκαφής και εκσκαφή κάτω από κάτω από την συγκεκριμένη ασπίδα.

Το κύριο πλεονέκτημα της μεθόδου αυτής είναι ότι σε περιοχές με πολύ μικρό πάχος υπερκειμένων, όπου δεν μπορεί να εφαρμοσθή συμβατική μέθοδος διάνοιξης σηράγγων, δεν εμποδίζει τις λειτουργίες στην επιφάνεια του εδάφους.

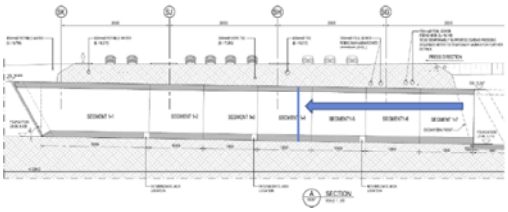
Στο συγκεκριμένο έργο κατασκευάστηκαν τρεις σήραγγες / υπόγειες διαβάσεις με την μέθοδο του Box Pushing. Η μεγάλη σήραγγα είχε μήκος 80m περίπου και πλάτος κιβωτίου 15m και οι δύο μικρές είχαν μήκος 45m περίπου η κάθε μία και πλάτος κιβωτίου 10m.

Υπόγειες Διαβάσεις
Tunnel Jacking (Jacked Box Tunnelling)



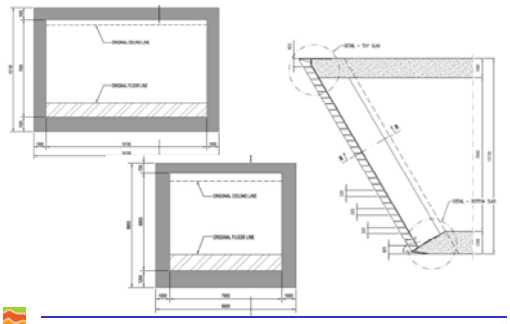
Εργοταξιακή διάταξη κατασκευής των κιβωτίων της μεγάλης σήραγγας πριν από την έναρξη της ώθησης.

Υπόγειες Διαβάσεις
Tunnel Jacking (Jacked Box Tunnelling)



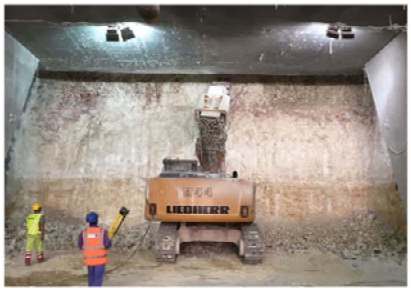
Σχηματική απεικόνιση της μεγάλης σήραγγας κάτω από τον αυτοκινητόδρομο. Το ελάχιστο υπερκείμενο (στην έξοδο) ήταν 3.80m.

Υπόγειες Διαβάσεις - Jacked Box Tunnelling



Διατομές της μεγάλης και των μικρών σηράγγων, καθώς και διαμόρφωση του χαλύβδινου τμήματος που προσαρμόζεται έμπροσθεν του πρώτου κιβωτίου, και είναι αυτό που διεισδύει στο έδαφος.

Υπόγειες Διαβάσεις Jacked Box Tunnelling



Μετά την εκπόνηση των μελετών για τις σήραγγες και τις κατασκευές με E&E οι Κοινοπραξίες έπρεπε να εκτιμήσουν την επίπτωση της κατασκευής των έργων του ΜΕΤΡΟ στις όμορες κατασκευές.

Αυτό ήταν το αντικείμενο της **'Έκθεσης Επιπτώσεων Κατασκευαστικών Εργασιών**. Η έκθεση αυτή συνοδεύετο και από μία λεπτομερή αποτύπωση της κατάστασης όλων των κατασκευών εντός της ζώνης επιρροής των έργων.

Φάση Μελετών

- **Γεωτεχνική Μελέτη:**
  Κατασκευές με Εκσκαφή & Επανεπίχωση
- **Βασική Μελέτη Σηράγγων Κυκλοφορίας Συρμών**
- **Γεωτεχνική Μελέτη:**
  Συνδετήριες Σήραγγες & Υπόγειες Διαβάσεις

⇩

Έκθεση Επιπτώσεων Κατασκευαστικών Εργασιών

Στάδιο 1: Προκαταρκτική Εκτίμηση Επιπτώσεων

Στάδιο 2: Εκτίμηση Επιπτώσεων Δευτέρου Σταδίου

Στάδιο 3: Λεπτομερής Εκτίμηση Επιπτώσεων

Τέλος, βάσει των αποτελεσμάτων των μελετών και της εκτίμησης των επιπτώσεων των κατασκευαστικών εργασιών καταστρώθηκε το κατάλληλο Πρόγραμμα Οργανοθέτησης και Παρακολούθησης των Οργάνων και εξ αυτών της Συμπεριφοράς των Κατασκευών.

Σκοπός της οργανοθέτησης και της παρακολούθησης των οργάνων είναι να μετρηθούν οι μετακινήσεις του εδάφους και η επίδρασή τους στις υπάρχουσες κατασκευές με τρόπο που να επιτρέπη την άμεση σύγκρισή τους με τις αναμενόμενες συμπεριφορές.

Το όλο σύστημα περιελάμβανε άμεση πληροφόρηση (real time) για την λειτουργία των TBMs και πληροφορίες για τις κατασκευές εντός των ζωνών επιρροής των κατασκευαστικών εργασιών.

Φάση Μελετών

- **Γεωτεχνική Μελέτη:**
  Κατασκευές με Εκσκαφή & Επανεπίχωση
- **Βασική Μελέτη Σηράγγων Κυκλοφορίας Συρμών**
- **Γεωτεχνική Μελέτη:**
  Συνδετήριες Σήραγγες & Υπόγειες Διαβάσεις

⇩

Έκθεση Επιπτώσεων Κατασκευαστικών Εργασιών

⇩

Έκθεση Οργανοθέτησης και Παρακολούθησης Οργάνων

Κάποια ενδιαφέροντα στοιχεία σχετικά με το ΜΕΤΡΟ της Doha για να γίνη αντιληπτό το μέγεθός του.

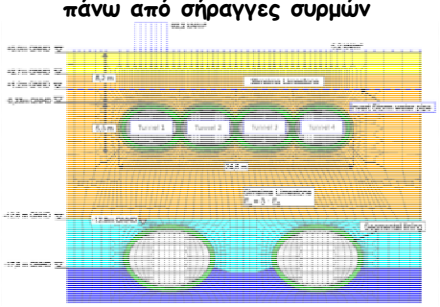
Σταθμός Msheireb

Κάτοψη: 75,000 m²
Μήκος κατά μήκος της Κόκκινης και Πράσινης Γραμμής: 350 m
Μήκος κατά μήκος της Χρυσής Γραμμής: 250 m

Στην φωτογραφία αυτή βλέπουμε τον σταθμό Msheireb στις αρχικές φάσεις κατασκευής του την 24η Μαρτίου 2016. Ο σταθμός έχει έκταση 75,000 m^2, μήκος κατά μήκος της Κόκκινης και Πράσινης Γραμμής 350 m και μήκος κατά μήκος της Χρυσής Γραμμής 250 m.

Υπήρξαν περιπτώσεις όπου αντιμετωπίσθηκαν σημαντικά κατασκευαστικά προβλήματα. Έτσι πέρα από την διάβαση με το Box Pushing Tunnelling κάτω από την λεωφόρο,

Σήραγγες αερισμού
πάνω από σήραγγες συρμών



έπρεπε να κατασκευασθούν 4 σήραγγες αφ' ενός με σε μικρό βάθος κάτω από την επιφάνεια του εδάφους (5.2m), αφ' ετέρου δε 7m περίπου πάνω από τις ήδη κατασκευασμένες σήραγγες της Πράσινης Γραμμής.

Κάθε γραμμή έπρεπε να κατασκευάση ένα πρόπλασμα σταθμού σε φυσικό μέγεθος, προκειμένου να διευκολυνθή η επιλογή των υλικών των αρχιτεκτονικών τελειωμάτων (πλακάκια, χρώματα κ.λπ.), μέχρι και την διαμόρφωση των τζαμιών (χώρων προσευχής) εντός των σταθμών και των αποχωρητηρίων.

Προπλάσματα Σταθμών

Κλίμακα 1 : 1 !!!

Παρομοίως, έπρεπε να παρουσιασθή στην Διοίκηση της Qatar Rail αλλά και στον Εμίρη και σε κυβερνητικά στελέχη βαγόνι των συρμών που θα χρησιμοποιηθούν.

Πρόπλασμα σε κλίμακα 1:1 συρμού του Μετρό της Doha

Πρόπλασμα σε κλίμακα 1:1 συρμού του Μετρό της Doha

Και ένα τελευταίο, αλλά αρκετά σημαντικό σημείο, σχετικά με το ΜΕΤΡΟ της Doha.

Transit Oriented Development

Transit Oriented Development is the exciting fast growing trend in creating vibrant, livable, sustainable communities. Also known as TOD, it's the creation of compact, walkable, pedestrian-oriented, mixed-use communities centered around high quality **train systems**. This makes it possible to live a lower-stress life without complete dependence on a car for mobility and survival.

Transit oriented development is also a major solution to the serious and growing problems of climate change and global energy security by creating dense, walkable communities that greatly reduce the need for driving and energy consumption. This type of living arrangement can reduce driving by up to 85%.

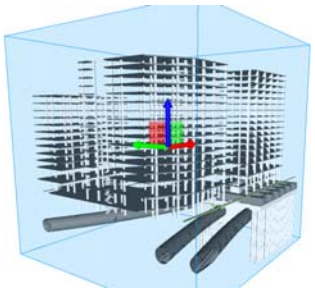
Η Qatar Rail υιοθέτησε την τάση αυτή και τρεχόντως σχεδιάζεται η ανάπτυξη μικρών έως μεγάλων γειτονιών πάνω και γύρω από 12 σταθμούς, με στόχο όχι μόνο να εξυπηρετήση το κοινό, αλλά και να ανακτήση μέρος της επένδυσης που έκανε για τη αγορά γης για την κατασκευή των σταθμών. Ήδη έχει προπωλήσει κτίρια σε διαφόρους φορείς, π.χ. στην Qatar Airways για την φιλοξενία του προσωπικού της, εξασφαλίζοντας 24/7 κυκλοφορία συρμών μέχρι το αεροδρόμιο.

Πάρα πολλά και ενδιαφέροντα τα προβλήματα για την κατασκευή των κτιρίων αυτών πάνω από τις υπάρχουσες σήραγγες και τους σταθμούς του ΜΕΤΡΟ, όπως φαίνεται στην διαφάνεια,

Transit Oriented Development

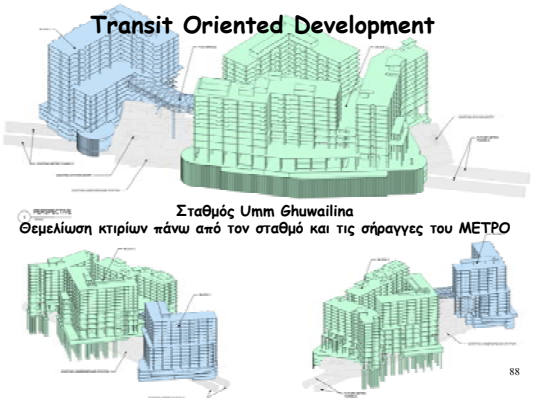
Σταθμός Umm Ghuwailina

Θεμελίωση κτιρίων πάνω από τις σήραγγες του ΜΕΤΡΟ



Γεωτεχνικά προβλήματα, όπως π.χ. ανάγκη κατασκευής πασσάλων πολύ κοντά στις σήραγγες που δεν πρέπει να μεταφέρουν πλευρικά φορτία (sleeved piles)

Transit Oriented Development



Σταθμός Umm Ghuwailina
Θεμελίωση κτιρίων πάνω από τον σταθμό και τις σήραγγες του ΜΕΤΡΟ

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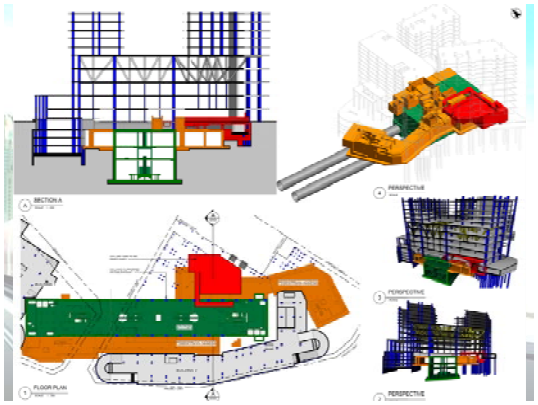
αλλά κυρίως στατικά, με την ανάγκη κατασκευής συστημάτων μεταφοράς των φορτίων (transfer systems) εκατέρωθεν των σταθμών.



Τέλος, πρέπει να αναφέρω την εκτεταμένη χρήση του συστήματος **BIM (Building Information Modeling)**. Το Building information modeling είναι μια διαδικασία που περιλαμβάνει την δημιουργία και διαχείριση ψηφιακών απεικονίσεων φυσικών και λειτουργικών χαρακτηριστικών κατασκευών και όχι μόνο. Τα **Building information models** (**BIMs**) είναι αρχεία τα οποία μπορούν να εξαχθούν, να ανταλλαχθούν ή να διατεθούν σε κάποιο δίκτυο, προκειμένου να υποβοηθήσουν στην λήψη αποφάσεων σχετικά με μία κατασκευή. Το

λογισμικό BIM χρησιμοποιείται πλέον παγκοσμίως για σχεδιασμό, μελέτη, κατασκευή, λειτουργία και συντήρηση ποικίλων έργων υποδομών.

https://www.youtube.com/watch?v=goxvLOYuiCo

ΔΙΑΚΡΙΣΕΙΣ ΕΛΛΗΝΩΝ ΓΕΩΜΗΧΑΝΙΚΩΝ

Γιώργος Λεβέντης

ENR names George Leventis "Top 25 Newsmaker"

ENR recently named Langan International Managing Director George E. Leventis as a "Top 25 Newsmaker" for his work on Greece's €10-billion, 1000-KM roadway program. This year ENR recognized individuals who have served the best interests of the construction industry and the public. "Newsmakers" are innovative, overcome challenges, and their accomplishments offer benefits that will have an impact beyond their own companies.

Leventis has a long history of overcoming the challenges that accompany complex projects in Greece, including his involvement in the Athens Olympics of 2004 and the Rion-Antirion Bridge. These experiences prepared him to navigate the intense political environment and ongoing financial crisis that surrounded the Olympia Odos motorway project, for which he served as the lender's technical advisor since 2006 and was completed in 2017. This landmark project provides critical links to key destinations in Greece and is a vital part of the Trans-European Network.

"What should have been about $30 million per month in construction work slowed down to about $3 million during the crisis. But, working together with all the stakeholders, we kept it going," says Leventis.

Αναφορά στο περιοδικό enr.com της 22ας Ιανουαρίου 2018

Lending skills and experience to complete Greek roadways

George Leventis is no stranger to Olympian feats—literally. Recruited in 1998 to oversee master-planning for fast-track construction of facilities in Athens for the 2004 Olympic Games, he honed his ability to "deal with different people with different agendas and needs. At the end of the day, I had to pull things together," he says.

That experience left him well prepared to navigate Greece's notoriously intense politics and ongoing financial crisis and help stakeholders to complete more than 1,000 kilometers of roadway throughout the country—an estimated $10-billion program.

Leventis, managing director of U.S. design firm Langan International, has long advocated for and gained experience with construction public-private partnerships in Greece, particularly on the Rion-Antirion Bridge, completed in 2001. As director-general of the Olympics organizing committee, he brought up the idea of privatizing Olympic venues but encountered regulatory obstacles, he recalls. Leventis calls the experience "gut-wrenching, but it allowed me to become more confident in dealing with issues openly in a public forum."

That diplomatic ability proved crucial when Langan was hired as technical adviser to Olympia Odos, one of five concessionaires striving to build or improve Greek roads to boost tourism and show P3 viability. Economic crises, both local and global, caused uneasy lenders to consider shutting off money to the consortia building the network, which would have jeopardized thousands of jobs as well as billions of dollars in investment. "George's role was very instrumental in keeping the construction going in such a harsh economic environment," says Panayiotis Papanikolas, CEO of Olympia Odos. The project was suspended for three years and required negotiations among the concessionaire, the Greek state, lenders and the construction joint venture. He says Leventis went beyond "his contractual responsibilities as technical adviser and participated in many discussions and negotiations with the state and the contractor. He managed to gain the respect and trust of all parties."

Two years of negotiations modified the projects' scope of work and deadlines. Changes included reduced bank loans and claims, a government agreement to cede expected toll revenue and cover inflation for extended deadlines, and increased European Union contributions. It was still rough going, with austerity measures, national riots, changing governments and anti-toll sentiment. But the consortia "collaborated to keep enough money trickling in" to continue construction and complete work in 2017, recalls Leventis, adding, "What should have been about $30 million per month in work was about $3 million. But we kept it going."

Aileen Cho

Χρυσόθεμις Παρασκευοπούλου
Assistant Editor του περιοδικού Geomechanics and Geoengineering International Journal

Η συνάδελφος και μέλος της ΕΕΕΕΓΜ Χρυσόθεμις Παρασκευοπούλου, Lecturer in Rock Engineering/Mechanics and Tunnelling, School of Earth and Environment, University of Leeds επελέγη τον Ιούλιο 2017 ως Assistant Editor του περιοδικού Geomechanics and Geoengineering International Journal at Taylor & Francis Group

Ιωάννης Μάρκου
Member of the Editorial Board "International Journal of Geosynthetics and Ground Engineering"

Ο συνάδελφος και μέλος της ΕΕΕΕΓΜ Ιωάννης Μάρκου Αναπληρωτής Καθηγητής στο Τμήμα Πολιτικών Μηχανικών της Πολυτεχνικής Σχολής του Δημοκριτείου Πανεπιστημίου Θράκης αποτελεί μέλος της Επιτροπής Σύνταξης (Editorial Board) του περιοδικού Γεωτεχνικής Μηχανικής. Το περιοδικό ονομάζεται "International Journal of Geosynthetics and Ground Engineering" (Springer (http://link.springer.com/journal/40891).

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ΠΡΟΣΕΧΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΚΔΗΛΩΣΕΙΣ

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

micro to MACRO - Mathematical Modelling in Soil Mechanics, May 29-June 1, 2018, Reggio Calabria, Italy, www.microtomacro2018.unirc.it

GeoReinforcement Workshop, 4 - 5 June 2018, Munich, Germany, https://iqs.wufoo.com/forms/q10dk31u19dx00v/

International Conference on Deep Foundations and Ground Improvement - Urbanization and Infrastructure Development: Future Challenges, June 5-8, 2018, Rome, Italy, www.dfi.org/dfieventlp.asp?13310

GeoBarrier Workshop, 6 - 7 June 2018, Munich, Germany, https://iqs.wufoo.com/forms/q10dk31u19dx00v/

XVI Danube-European Conference on Geotechnical Engineering: Geotechnical Hazards and Risks: Experiences and Practices, 7 - 9 June 2018, Skopje, Former Republic of Yugoslav www.decge2018.mk

16th European Conference on Earthquake Engineering (16thECEE), 18-21 June 2018, Thessaloniki, Greece, www.16ecee.org

CPT'18 4th International Symposium on Cone Penetration Testing, 21-22 June 2018, Delft, Netherlands, www.cpt18.org

PATA DAYS 2018 - 9th International INQUA Meeting on Paleoseismology, Active Tectonics and Archeoseismology, 24-29 June 2018, Chalkidiki, Greece, www.patadays2018.org

NUMGE 2018 9th European Conference on Numerical Methods in Geotechnical Engineering, 25-27 June 2018, Porto, Portugal, www.numge2018.pt

RockDyn-3 - 3rd International Conference on Rock Dynamics and Applications, 25-29 June 2018, Trondheim, Norway, www.rocdyn.org

ICOLD 2018 26th Congress – 86th Annual Meeting, 1 - 7 July 2018, Vienna, Austria, www.icoldaustria2018.com

9th International Conference on Physical Modelling in Geotechnics (ICPMG 2018), 17-20 July 2018, London, UK, www.icpmg2018.london

ICSSTT 2018 - 20th International Conference on Soil Stabilization Techniques and Technologies, July 19 - 20, 2018, Toronto, Canada, https://waset.org/conference/2018/07/toronto/ICSSTT

GeoChine 2018 - 5th GeoChina International Conference Civil Infrastructures Confronting Severe Weathers and Climate Changes: From Failure to Sustainability, July 23-25, , HangZhou, China, http://geochina2018.geoconf.org

UNSAT2018 The 7th International Conference on Unsaturated Soils, 3 - 5 August 2018, Hong Kong, China, www.unsat2018.org

China- Europe Conference on Geotechnical Engineering, 13-16 August 2018, Vienna, Austria, https://china-euro-geo.com

CRETE 2018 6th International Conference on Industrial & Hazardous Waste Management, 4-7 September 2018, Chania, Crete, Greece, www.hwm-conferences.tuc.gr

EUCEET 2018 - 4th International Conference on Civil Engineering Education: Challenges for the Third Millennium, 5-8 September 2018, Barcelona, Spain, http://congress.cimne.com/EUCEET2018/frontal/default.asp

SAHC 2018 11th International Conference on Structural Analysis of Historical Constructions "An interdisciplinary approach", 11-13 September 2018, Cusco, Perύ http://sahc2018.com

26th European Young Geotechnical Engineers Conference, 11 - 14 September 2018, Reinischkogel, Austria, www.tugraz.at/en/institutes/ibg/events/eygec

11th International Conference on Geosynthetics (11ICG), 16 - 20 Sep 2018, Seoul, South Korea, www.11icg-seoul.org

CHALK 2018 Engineering in Chalk 2018, 17-18 September 2018, London, U.K., www.chalk2018.org

International Symposium on Energy Geotechnics SEG - 2018, 25-28 September 2018, Lausanne, Switzerland https://seg2018.epfl.ch

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, London, United Kingdom, www.ice.org.uk/events/global-engineering-congress

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

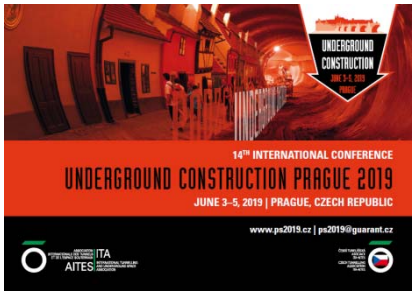
International Symposium Rock Slope Stability 2018, 13-15 November, 2018, Chambéty, France, www.c2rop.fr/symposium-rss-2018

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

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

14th international Conference "Underground Construction", 3 to 5 June 2019, Prague, Czech Republic, www.ucprague.com

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



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

The ITA-AITES Czech Tunnelling Association cordially invites you to 14th International Conference entitled "**Underground Construction Prague 2019**", which will be held in Prague, the capital of the Czech Republic, **June 3–5, 2019**.

This is the largest Czech tunnelling conference, which is held regularly every three years. Past conferences, especially Underground Construction Prague 2010, 2013 and 2016, confirmed that the Prague conference thanks to its scientific programme, venue and social programme found a firm position among similar European conferences.

This confirms the participation of distinguished European and international experts at each conference.

The joint conference will be held at the Clarion Congress Hotel Prague and will include a technical exhibition and a poster session.

The conference is endorsed by the International Tunnelling and Underground Space Association (ITA). We are looking forward to your active participation and exchange of new information and experience.

We are looking forward to your active participation and exchange of new information and experience.

Thematic Sessions

1. Conventionally excavated tunnels
2. Mechanically excavated tunnels
3. Other underground structures, repositories, reconstructions and history
4. Geotechnical investigation and monitoring
5. Numerical modelling, BIM, research and development
6. Equipment, operational safety and maintenance
7. Risk management, contractual relationships and funding

CONTACTS

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Phone: +420 702 062 610, e-mail: pruskova@ita-aites.cz, website: www.ita-aites.cz

Secretariat of the Preparatory Committee

SATRA, spol. s r. o., Sokolská 32, 120 00 Prague 2, Czech Republic
Phone: +420 296 337 181, fax: +420 296 337 189

Organising agency

GUARANT International spol. s r. o., Na Pankráci 17, 140 21 Prague 4, Czech Republic
Phone: +420 284 001 444, fax: +420 284 001 448, e-mail: ps2019@guarant.cz, website: www.guarant.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

For additional information, please contact the secretariat of the congress, Ms. Lara Leite

CMN2019, Universidade do Minho, Departamento de Engenharia Civil, 4800-058 Guimarães - Portugal
Email: cmn2019@civil.uminho.pt
Telephone: +351 253 510 748
Fax: +351 253 510 217

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

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

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
1-4 December 2019, Okinawa, Japan

Contact Person: Prof. Norikazu Shimizu, jsrm-office@rocknet-japan.org

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

Contact person: Prof. Leena Korkiala-Tanttu
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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

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.

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
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Website: http://www.isc6-budapest.com
Email: info@isc6-budapest.com

ΕΝΔΙΑΦΕΡΟΝΤΑ ΓΕΩΤΕΧΝΙΚΑ ΝΕΑ

Massive sinkhole opens in Rome, swallowing cars

Over 20 families were evacuated after a huge sinkhole opened up in a northwestern neighbourhood of Rome, swallowing several cars.

Fortunately, no injuries have been reported, but the area remained closed off on Thursday morning after a large part of the ground collapsed shortly before 6pm on Wednesday.

The sinkhole, measuring around ten metres deep, appeared in the Balduina district, a residential area northwest of Vatican City.

Seven parked cars were sucked into the chasm, and approximately 22 families evacuated from the residential area.

"In the last few days while [construction workers] were working, I felt the floor of the house tremble and was very worried," one resident told Italy's Rai News.

Several social media users joked about the 1945 film 'Roma città aperta' (Rome, open city) as they shared photos revealing the extent of the damage caused.

"Two teams of firefighters worked throughout the night on the landslide," said the Italian Fire Service.

"At the scene, it was arranged to evacuate two apartment buildings as a precautionary measure, secure the area, and assist the local population."

The road where the sinkhole opened up is marked on the above map.

Further stability checks were under way on Thursday morning, while firefighters are also working to establish the cause of the collapse.

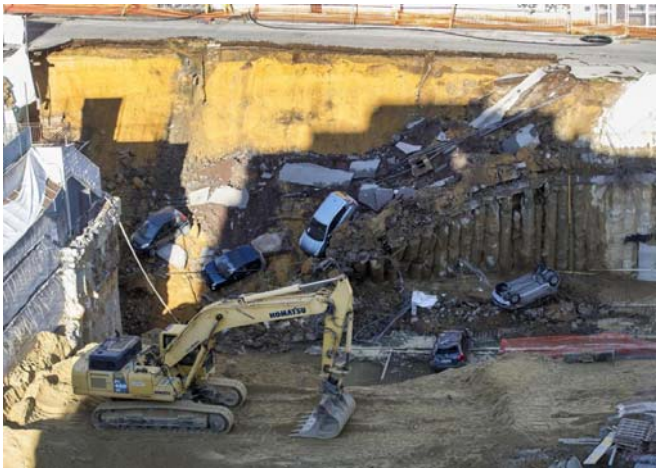
The area is near a building site, where construction workers began demolition of buildings in October 2017 to make way for new residential buildings and underground parking space.

Works had been carried out in the same spot where the sinkhole appeared between January 25th and 28th, after reports of significant water leaks, which had however continued since the works. The sinkhole came after a day of rain in the Italian capital, which even saw some snow in the Roman outskirts.

Rome's public prosecutor has opened an inquiry into the incident and will send engineers and geologists to establish what caused it. Two people were placed under investigation on Thursday for potential "culpable disaster": the legal representative of the owners of the land, and that of the company responsible for the construction site where the sinkhole appeared.

Mayor Virginia Raggi said that authorities would find out where the responsibility lay. "Anyone who made an error will pay," she told Italian media.

In 2016, a giant 200-metre sinkhole opened up in Florence after a water pipe broke, causing water to erode the road. Twenty parked cars were swallowed by that sinkhole next to the city's Ponte Vecchio, which was estimated to cost the city €5 million to repair.



(Catherine Edwards / THE LOCAL, 15 February 2018, https://www.thelocal.it/20180215/massive-sinkhole-rome-cars-balduina)

Road collapse near Vatican City in Rome destroys 7 cars, 20 families evacuated

A large stretch of a road near Vatican City in northwestern Rome, Italy collapsed on February 14, 2018, taking with it seven parked cars. There were no injuries reported but 2 nearby buildings with 22 families were ordered to evacuate. The event followed a day of heavy rain and snow.

The incident took place in Balduina, a residential area northwest of Vatican City, creating a chasm more than 9 m (30 feet) deep.

ANSA news agency said emergency crews have shut down a pipeline damaged by the collapse and water has been brought in to ensure there's a supply for residents.

The stretch of road which collapsed is near a building site, where construction workers began demolition of buildings in October 2017 to make way for new residential buildings and underground parking space.

Officials are checking other nearby buildings for structural damage.

(Science Global News, February 15, 2018, http://scienceglobalnews.com/environment/road-collapse-near-vatican-city-in-rome-destroys-7-cars-20-families-evacuated)

(σ.σ. Από τις φωτογραφίες προκύπτει ότι πρόκειται μάλλον περί αστοχίας της αντιστήριξης παρά για sinkhole).

HDPE-Lined Reservoir for Artificial Snow on an Alpine Slope

Ischgl is an internationally renowned ski resort in the Silvretta Mountains of Tyrol. Plenty of natural snowfall supports 200km of downhill pistes (compacted snow runs), but the ability to provide artificial snow early in the season enables the resort to open sooner and gives skiers a longer and more dependable window for time on the slopes.

Large reservoirs are needed to support artificial snow production for these resorts. For mountainous locations like Ischgl, reservoir stability must be carefully monitored and quick corrections are sometimes needed.

The nearly 60,000 m^3 of water storage in the new artificial snow-supporting reservoir enabled the renowned resort to open earlier than ever in 2017.

A NEW ARTIFICIAL SNOW SUPPORT RESERVOIR

The new reservoir Viderböden is the heart of the snow-making system for Ischgl. The project was initiated after landslides threatened the previous storage pond's location. The site operator Silvrettaseilbahn AG identified a new, geologically secure section of slope on which to construction a new reservoir. It also specified an updated lining system to ensure efficient containment of water and which could provide long-term support in the difficult, Alpine environment.

The resulting design provided 60,000 m³ of water storage to guarantee snow reliability.

To ensure the least amount of disruption to the resort's infrastructure, the new reservoir was placed as close as possible to the previous one without sacrificing geotechnical safety. This placement enabled the new storage facility to efficiently connect to the existing and extensive water network pipelines that support artificial snow production. New earthworks were minimized, as a result.

In just 3.5 months, the heart-shaped reservoir was constructed and sealed with high-density polyethylene (HDPE) geomembrane, per waterproofing standards in accordance with Austrian Standard (ÖNORM) S 2073, which also included a protective geotextile and gravel cover.

The structured geomembrane provided exceptional frictional characteristics and stability for the steep installation.

Along the way, the steep slope angle challenged the construction, but it also gave the engineering team an ideal situation with which to utilize the impermeable containment performance of the HDPE lining system. The steep embankment enabled more usable depth, so the reservoir could store a greater volume of water without altering the surface area design. For the resort, it meant a greater amount of artificial snow could be called upon if needed.

A structured geomembrane—MICROSPIKE High Grip waterproofing membrane—was used. The surface of the geomembrane offers ≥20,000 knobs/m² for enhanced frictional characteristics and stability on sloped installations (along with protective and drainage pathways). The knob-free welding areas on the HDPE panels facilitated clean, efficient seaming for system integrity. In addition, the material was energetically enriched (BIO +) in order to reduce the growth of algae and enable the production of artificial snow at higher temperatures.

IMMEDIATE, BENEFICIAL IMPACT

The reservoir was completed in October 2017, which enabled Ischgl to open its slopes on November 23—its earliest start date on record.

(Chris Kelsey / Geosynthetica, January 31, 2018, https://www.geosynthetica.net/artificial-snow-reservoir-geomembrane-skiing)

Desludging Wastewater Ponds Using Geotextile Dewatering Bags

Johnny Oriokot, Donovan Bate, and Gerard Dirks

When wastewater treatment ponds reach their capacity, the options available are either to build new or empty existing facilities. These ponds must be desludged to make available additional space for waste. Strict environmental regulations in wastewater treatment, though necessary, can complicate carrying out functional upgrades to a facility.

Here, geotextile dewatering bags provide an efficient, cost-effective method for desludging works. They can work within a limited footprint and effectively contain the material that needs to be removed and disposed of with minimal environmental impact.

GEOTEXTILE DEWATERING BAGS IN SOUTH AFRICAN WASTEWATER

The ultimate goal of wastewater treatment is, of course, to convert unsuitable fluid into an effluent that is safe to be returned to the environment. Solid particles (sludge) are separated from the wastewater and transported to safe disposal sites or contained in a tailings storage facility.

Cost-effective and efficient solids separation remains a challenge to wastewater tailings facilities around the world.

South Africa serves as a strong example for tackling common wastewater treatment issues with the utilization of geotextile dewatering bags. Here, multiple wastewater treatment sites were identified as having reached their maximum storage capacity. Excess sludge accumulation was a major factor.

Sludge accumulation at a wastewater tailings facility.

For all of the facilities cited in Figure 1, the option of building a new tailings dam was cost-prohibitive. (This is the case nearly all wastewater treatment plants find themselves in when reaching capacity.) Furthermore, the tailings storage facilities in place at these sites, like so many others, were older and had not been constructed with an adequate lining system. Thus, the sites presented an environmental concern over potential effluent leakage.

To remedy the situation and relieve these facilities of the concern over the old tailings storage cells, a project was initiated to remove sludge from each facility, rehabilitate the storage cells, and install modern lining systems. The work was conducted not only to achieve better environmental and efficiency performance but to bring the facilities quickly up to the standards set by new regulations enacted by the Department of Water Affairs.

SLUDGE REMOVAL AND DEWATERING OPTIONS

Dredging is by far the most common form of sludge removal followed by other methods that involve mechanical removal from a tailings dam. The sludge is removed, dried, and transported to a landfill or a land-application facility. Dredging, however, can be an extremely difficult, time-consuming, and costly process. Dredging can also damage a lining system, which can compromise the structural integrity of the sludge pond and lead to seepage.

For the South African projects described here, limited budget and time-sensitive operational upgrade windows for desludging the wastewater ponds pressured the project teams to find alternative methods. On-site geotextile dewatering bags were found to be a more economical and smaller footprint solution.

Mechanical dredging method of excess sludge from a wastewater tailings facility.

DESIGNING WITH DEWATERING BAGS

For the projects here, a dewatering area was lined with a 1-mm-thick geomembrane to prevent local erosion and to collect all the effluent that would be released from the geobags during the dewatering process. The effluent would then be channeled back into the dam or taken for further treatment.

The geotextile dewatering bags made out of UV-stabilized woven polypropylene (PP) geotextile material with high-strength seams were used to capture the dredged sludge whilst minimizing water loss. The seam strength of a geotextile dewatering bag is essential for durability in service and to withstand the stresses associated with pumping the material at high pressures. The thread used to stitch the bags in this project series offered a higher breaking strength than the geotextile itself, thus providing sufficient tensile strength to the geobags.

One of the primary sources of efficiency in the use of geotextile dewatering bags rests in how they allow water to flow through the geotextile pores while filtering out the solids, which are contained inside the bag. Even solids smaller than the aperture openings in the fabric are contained, as a filter cake builds up during the dewatering process but does not entirely block water flow. This creates an equivalent two-stage filter with filtration efficiencies above 98% for fine-grained material filtered through woven, high-strength geotextile dewatering bags (Bindra 2002).

Preparation of ground prior to operation.

In order to accommodate the pipe connections, two inlets per bag of standard size 200 mm were allowed for. These inlets accommodated pipe sizes up to 200 mm diameter. When filling processes were completed, the pipes were removed and the inlets were tied off.

The pumping rate was kept below 40 m^3/h. A manifold was present to split the flow and reduce the inlet speed in the event a pump exceeded the designed rate. The pumping rate did not affect the flow-through rate of the geotextile dewatering bags, because the aperture size of the geotextile controls the outflow.

When it comes to disposal, the final disposal site for the dewatering geotextile bags should be as close to the generation area as possible in order to minimize transportation costs. The retained solids can be safely disposed of or perhaps reused beneficially, such as in fertilizer. The geobags themselves must by disposed of responsibly, as they are not reusable.

In selection of a disposal site, one must:

- Ensure that the disposal site is not located in a sensitive area where disposal is not permissible
- Ensure that the sludge disposal site is located as far as possible from the area where the final effluent is discharged to limit possible contamination of the final effluent, as well as to limit possible contribution of contaminants to the water resource
- Allow for the maximum buffer zones, greater than 400 m from surface water
- Consider the slope of the disposal site to minimize run-off, erosion, and ponding.
- Ensure the disposal site is not within the 1:100 year flood line.

No flocculants were necessary, as the use of geobags enabled the material to dewater quick enough by gravity only, further reducing project cost.

Filling of the geotextile dewatering bags.

While the duration dewatering and consolidation by this method varies depending on the type of geotextile, bag size, fill material, and site conditions, in the authors' experience it takes on average a week for these types of bags to drain.

TAKEAWAYS FOR WASTEWATER ENGINEERING

Geotextile dewatering bags are capable of competing economically with other dewatering techniques used at wastewater treatment plants. The use of a geobag technique is passive. It does not require extensive or constant monitoring and maintenance of equipment. As such geotextile dewatering bags are, in general, 50 – 70% cheaper than other sludge removal methods, when considering all factors (e.g., construction and dewatering time, labor, machinery costs). The simplicity in their use for separating solids and how simple it is to contain the effluent that is dewatered also makes geobags an environmentally friendly engineering solution. Aquaculture, industrial processing, and sedimentation ponds are some other applications that benefit from the utilization of geotextile dewatering bags.

Filtration through the geotextile dewatering bags.

Geobag size selection is dependent on the volume that needs to be removed from a tailings facility and the space available on site where the dewatering bags will be placed. The largest geobag in the project noted here had a 15m circumference and was 60m long. This provided approximately 720 m^3 of volume.

The cost of geotextile dewatering bags is determined by the woven geotextile material, the thread strength, and the stitching process.

One can also find advantages in measuring the volume of waste that can be extracted from a tailings dam per month per bag, though this analysis has not yet been conducted for the sites noted here in South Africa.

Johnny Oriokot, Donovan Bate, and Gerard Dirks work for Fibertex South Africa. Learn more at www.geotextilesafrica.co.za and www.fibertex.com.

RECOMMENDED READING

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(Chris Kelsey / Geosynthetica, January 29, 2018, https://www.geosynthetica.net/geotextile-dewatering-bags-wastewater-sludge)

Reinforced Soil Wall Supports 1000-Ton Crane Working Platform

The Elan Valley Aqueduct (EVA) is an important part of the water supply for Birmingham City (Wales) and its surrounding area. The principal structure is 100 years old. The 120 km long EVA discharges 300 million liters of water per day in the Frankley Water Treatment Works (WTW), supplying 1.2 million people with potable water and future reserves in the event of emergency.

When Severn Trent Water determined that the aging system needed to be rehabilitated for future dependability, a new bypass conduit with a 1.8 km long, 3m diameter tunnel was proposed. The work required the construction of a horizontal working platform, one that had to be robust enough to support a 1000-ton crane and the assemblage of a 150 ton tunnel boring machine (TBM).

REINFORCED WORKING PLATFORM

For the site conditions, expected construction traffic, and the size of the essential TBM, the working platform was designed at 160m long and maximum 14m high. A reinforced soil wall was needed to support the massive loads on the hillside location.

The working platform design used two strengths of geogrids from Strata Geosystems (120 and 60 kN/m). This approach

enabled the site crews to utilized site-won material as part of the cut-and-fill balance and to minimize the amount of fill that would be needed.

Site-won materials were, in fact, required, to keep the project costs under control. These soils contained a high fine soils content, which made them very susceptible to weather conditions.

SUPPORTING A 1000-TON CRANE

A 1000-ton crane was installed on the working platform to enable the assembly of the tunnel boring machine. The platform needed to be level with a working area at one end of the new bypass tunnel, downstream of the project.

To achieve this, the reinforced soil wall was needed. Site-won material was also to be used in cofferdam works surrounding the TBM launch shaft.

The slope angle for the reinforced wall was 85°. The reinforced working platform was constructed on top of the structure. The granular material utilized beneath the platform had a 970mm thickness and biaxial geogrids distributed the loads. A a steel mesh facing (B1131) was used to achieve the extreme slope angle, while the layers of the reinforced wall were protected with erosion control matting (LANDLOK® TRM450).

In total, 43 layers of soil and reinforcement were required to complete the massive wall and working platform. Primary reinforcement was provided by StrataGrid™ (again at 120 kN/m and 60 kN/m strengths), which was used with a wrap-around approach.

Geosynthetics Limited served as Strata Geosystems local partner for the construction. P J Martin Groundworks and Civil Engineering provided construction expertise (and has built four of the walls on the site). The entire working platform and reinforced works were completed in just 8 weeks, despite inclement weather.

HIGHLIGHTS OF THE DESIGN

- Saved 40% of cost versus a conventional concrete wall
- Lower carbon emissions for the construction works through use of local soils
- Technically sound, high-strength system
- Faster construction

(Chris Kelsey / Geosynthetica, February 1, 2018, https://www.geosynthetica.net/working-platform-tbm-reinforced-soil)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΣΕΙΣΜΟΙ

Sea Slime Can Trigger 65-Foot Mega-Tsunamis

A layer of ooze made of microscopic fossils may underlie Earth's biggest landslides, a new study finds.

The biggest landslides on Earth are not on dry land but rather on the seafloor. For instance, the volcanic eruption of Mount St. Helens in 1980 triggered a collapse of about 0.7 cubic miles (3 cubic kilometers) of rock, but the Storegga "megaslide" offshore Norway about 8,150 years ago sent more than 1,000 times more material crashing downward, previous research found.

Submarine landslides are not just perils for life underwater; they can trigger catastrophic tsunami that can wreak havoc on land. For example, prior work suggested that the Storegga megaslide triggered a tsunami that deluged surrounding coasts with waves up to 65 feet (20 meters) high.

One-fifth of all tsunamis may be caused by submarine megaslides, said study lead author Morelia Urlaub, a marine geoscientist at the Geomar Helmholtz Centre for Ocean Research in Kiel, Germany. In addition, submarine landslides are "a threat to any infrastructure on the seabed, such as those related to hydrocarbon exploration, pipelines and telecommunication cables, affecting our internet traffic," she told Live Science.

Oddly, the largest submarine landslides happen on nearly flat slopes inclined less than 3 degrees. Prior work found the kind of terrain left in the aftermath of these landslides suggests great expanses of seafloor glided over weak layers of material embedded within more-stable layers of sediment.

Scientists have proposed many possibilities for what material could make up these weak layers, including liquefied sand and "flammable ices" known as clathrates, Urlaub said. However, it was nearly impossible to say what these weak layers were because they were typically destroyed along with the landslides.

Now, in a first, Urlaub and her colleagues have identified the weak layer behind a submarine megaslide — a layer of ooze made of microscopic fossils.

Urlaub was analyzing ocean drilling data from 1980 when she realized it included samples from the seafloor just outside the Cap Blanc slide, a 149,000-year-old megaslide offshore northern Mauritania, in northwest Africa, that propelled more than 7.2 cubic miles (30 cubic km) of material over a seafloor gently inclined at just 2.8 degrees. She cross-referenced that information with high-resolution seismic data gathered in the same area in 2009.

Together, these data revealed that at the base of the Cap Blanc slide was a sediment layer less than about 33 feet (10 meters) thick. The layers were rich in diatoms, which are single-celled algae that live in glassy and often intricate shells. When these diatoms die, the remains of their shells create a silica-rich goop. Such diatom ooze layers are common on the margins of many continents, the researchers said.

This diatom layer was topped by a layer of clay sediment. The researchers suggested that this arrangement may help set the stage for submarine landslides. As weight builds up on top of the clay layer, it squashes the diatom layer, squeezing out water. As the pressure builds, this water gets forced into the clay, and the clay or the interface between the clay and the diatoms weakens, enabling landslides.

The researchers suggested that this diatom ooze may help to explain many large submarine landslides worldwide. "If diatom layers are a major factor in triggering large submarine landslides, then understanding where such oozes are deposited might help in assessing hazards," Urlaub said. "However, more studies are needed to really understand the processes and the conditions that lead to failure before being able to predict submarine landslides."

The scientists detailed their findings online Feb. 9 in the journal Geology.

(Charles Q. Choi / Live Science Contributor, February 14, 2018, https://www.livescience.com/61756-sea-slime-mega-tsunamis.html?utm_source=ls-newslet-ter&utm_medium=email&utm_campaign=20180214-ls)

Diatom ooze: Crucial for the generation of submarine mega-slides?

Morelia Urlaub, Jacob Geersen, Sebastian Krastel, Tilmann Schwenk

Numerous studies invoke weak layers to explain the occurrence of submarine mega-slides (>100 km^3), in particular those on very gentle slopes (<3°). Failure conditions are thought to be met only within this layer, which is embedded between stable sediments. Although key to understanding failure mechanisms, little is known about the nature and composition of such weak layers, mainly because they are destroyed with the landslides. This study is the first to place detailed constraints on the weak layer for one of the submarine mega-slides that occurred on the nearly flat, subtropical, northwest African continental slopes. Integrating results from the Ocean Drilling Program with high-resolution seismic reflection data, we show that the failure surfaces traced into the undisturbed sedimentary sequence coincide with thin (<10 m) diatom ooze layers capped by clay. As diatom oozes are common on many continental margins, we suggest a new margin-independent failure mechanism to explain submarine mega-slides at low-gradient continental slopes globally. Diatom oozes are susceptible to building up excess pore fluid during burial due to their high compressibility and water content. If a low-permeable clay cap prevents upward drainage, excess pore pressures accumulate at the ooze-clay interface, causing the shearing resistance to increase at a lower rate than the shear stress until failure can occur. Changes in global climate affect the abundance of diatoms and thus formation of diatom oozes, thereby preconditioning the sediments for failure. However, the actual timing of failure is independent of environmental changes.

(GeoScinceWorld / Geology (2018), DOI: https://doi.org/10.1130/G39892.1, February 09, 2018, https://pubs.geoscienceworld.org/gsa/geology/article-abstract/527938/diatom-ooze-crucial-for-the-generation-of?redirectedFrom=fulltext)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΓΕΩΛΟΓΙΑ

A Ticking Time Bomb of Mercury Is Hidden Beneath Earth's Permafrost

Climate change could unleash 15 million gallons of mercury trapped in permafrost. And that's just in the Northern Hemisphere.

When the mercury's rising in your thermometer, it may also be rising in the ocean.

According to a new study published Feb. 5 in the journal Geophysical Research Letters, there may be more than 15 million gallons (58 million liters) of mercury buried in the permafrost of the Northern Hemisphere — roughly twice as much mercury as can be found in the rest of Earth's soils, ocean and atmosphere combined. And if global temperatures continue to rise, all that mercury could come pouring out.

In geology, permafrost is defined as any soil that has been frozen for more than two years. In the Northern Hemisphere, permafrost accounts for about 8.8 million square miles (22.79 million square kilometers) of land — or roughly 24 percent of exposed Earth, according to the National Snow and Ice Data Center. Over time, naturally occurring compounds in the atmosphere, such as mercury and carbon dioxide, can bind with organic material in the soil and be frozen into permafrost, potentially remaining trapped underground for thousands of years before it thaws, the new paper said.

In the study, researchers drilled 13 permafrost soil cores from various sites in Alaska between 2004 and 2012. Then, they measured the total amounts of mercury and carbon in each sample, which proved consistent with thousands of other soil cores taken from other sites around the world, the paper said. Using the mercury contents of their 13 cores as a springboard, the researchers estimated the total amount of mercury sealed away below North American permafrost to be roughly 793 gigagrams — or more than 15 million gallons.

"There would be no environmental problem if everything remained frozen, but we know the Earth is getting warmer," study author Paul Schuster, a hydrologist at the U.S. Geological Survey in Boulder, Colorado, said in a statement. "This discovery is a game-changer."

Researchers have already observed climate-change-induced permafrost thawing, and there is likely more on the way: According to a 2013 study, the Northern Hemisphere will lose anywhere from 30 to 99 percent of its permafrost by 2100, assuming current human greenhouse-gas emissions continue unabated.

Previous studies have attempted to account for the billions of tons of carbon dioxide, methane and even "zombie pathogens" that could be loosed into the air and the oceans by melting permafrost. The environmental impact of a large-scale mercury leak, however, remains an unpredictable problem.

One major concern is that this trapped mercury could seep into nearby waterways and transform into methylmercury, a toxin that can cause motor impairment and birth defects in animals, Edda Mutter, science director for the Yukon River Inter-Tribal Watershed Council, said in a statement. Such contamination could travel swiftly up the food chain from microorganisms to humans, said Mutter, who was not involved in the new study.

"Rural communities in Alaska and other northern areas have a subsistence lifestyle, making them vulnerable to methylmercury contaminating their food supply," Mutter added.

The researchers are currently working on a follow-up study modeling the release of permafrost due to climate change, according to the statement.

(Brandon Specktor / Live Science Senior Writer, February 6, 2018, https://www.livescience.com/61665-mercury-permafrost-climate-change.html?utm_source=ls-newsletter&utm_medium=email&utm_campaign=20180206-ls)

Permafrost Stores a Globally Significant Amount of Mercury

Paul F. Schuster, Kevin M. Schaefer, George R. Aiken, Ronald C. Antweiler, John F. Dewild, Joshua D. Gryziec, Alessio Gusmeroli, Gustaf Hugelius, Elchin Jafarov, David P. Krabbenhoft, Lin Liu, Nicole Herman-Mercer, Cuicui Mu, David A. Roth, Tim Schaefer, Robert G. Striegl, Kimberly P. Wickland, and Tingjun Zhang

Abstract Changing climate in northern regions is causing permafrost to thaw with major implications for the global mercury (Hg) cycle. We estimated Hg in permafrost regions based on in situ measurements of sediment total mercury (STHg), soil organic carbon (SOC), and the Hg to carbon ratio (RHgC) combined with maps of soil carbon. We measured a median STHg of 43 ± 30 ng Hg g soil^{-1} and a median RHgC of 1.6 ± 0.9 μg Hg g C^{-1}, consistent with published results of STHg for tundra soils and 11,000 measurements from 4,926 temperate, nonpermafrost sites in North America and Eurasia. We estimate that the Northern Hemisphere permafrost regions contain 1,656 ± 962 Gg Hg, of which 793 ± 461 Gg Hg is frozen in permafrost. Permafrost soils store nearly twice as much Hg as all other soils, the ocean, and the atmosphere combined, and this Hg is vulnerable to release as permafrost thaws over the next century. Existing estimates greatly underestimate Hg in permafrost soils, indicating a need to reevaluate the role of the Arctic regions in the global Hg cycle.

Plain Language Summary Researchers estimate the amount of natural mercury stored in perennially frozen soils (permafrost) in the Northern Hemisphere. Permafrost regions contain twice as much mercury as the rest of all soils, the atmosphere, and ocean combined.

1. Introduction

Over thousands of years, sedimentation buried mercury (Hg) bound to organic material and froze it into the permafrost (Obrist et al., 2017). Permafrost is soil at or below 0°C for at least two consecutive years. The active layer is the surface soil layer on top of the permafrost that thaws in summer and refreezes in winter (Figure S1 in the supporting information). Hg deposits onto the soil surface from the atmosphere, where it bonds with organic matter in the active layer. Microbial decay then consumes the organic matter, releasing the Hg (Smith-Downey et al., 2010). At the same time, sedimentation slowly increases soil depth such that organic matter at the bottom of the active layer becomes frozen into permafrost. The organic matter consists almost entirely of plant roots, and, once frozen, microbial decay effectively ceases, locking the Hg into the permafrost. However, permafrost has begun to thaw under a changing climate (Hinzman et al., 2005; Romanovsky et al., 2008; Smith et al., 2010). Once the permafrost and associated organic matter thaws, microbial decay will resume and release Hg to the environment, potentially impacting the Arctic Hg balance, aquatic resources, and human health (Dunlap et al., 2007; Jonsson et al., 2017; Obrist et al., 2017; USGS Fact Sheet, https://www2.usgs.gov/themes/factsheet/146-00/, 2016). Model projections estimate a 30–99% reduction in the area of Northern Hemisphere permafrost by 2100, assuming anthropogenic greenhouse gases emissions continue at current rates (Koven et al., 2013). In a novel approach, we make the first-ever estimate of the storage of Hg in the Northern Hemisphere permafrost soils using empirical relationships based on in situ measurements of sediment total mercury (STHg) combined with published maps of soil organic carbon (Hugelius, Tarnocai, et al., 2013; Hugelius, Bockheim, et al., 2013).

(Geophysical Research Letters, Volume 45, Issue3, 16 February 2018, Pages 1463-1471, https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2017GL075571)

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That Sea Stack from Reddit Didn't Take 'Millions of Years' to Form

The gorgeous Irish sea-stack known as Dún Briste.

A photo of Dún Briste — a layered, chunky tower of rock rising off the western coast of Ireland —skyrocketed to the top of Reddit last week. But the post's captivating title — "What millions of years look like in one photo" — isn't exactly accurate, a geologist told Live Science.

The sea stack is old, but "almost certainly doesn't represent millions of years" of geological processes, Maria McNamara, a paleobiologist at the University College Cork, in Ireland, told Live Science in an email. "Rather, [it likely formed in] tens to hundreds of thousands of years," she said.

Its rapid formation (geologically speaking, at least) doesn't make this structure any less marvelous. The view of the sea stack from Ireland's County Mayo is stunning, which may explain why the picture has received about 57,300 up-votes on Reddit since its posting on Feb. 9. The layered, sedimentary rock formed during the Carboniferous, a 60-million-year-long period lasting from about 359 million to 299 million years ago. That's long before dinosaurs roamed the Earth. (In other words, the sea stack formed millions of years ago, but it formed very quickly.)

It's unclear whether Dún Briste has any fossils from the Carboniferous period. But if it does, they would likely be the remains of creatures that lived during that time period, including corals, brachiopods (clam-like creatures) and crinoids (sea animals that look like flowers), McNamara said.

When it formed, Dún Briste was still connected to the mainland. Looking at the sea stack's layers and edges, McNamara noticed that the structure shows evidence of onlapping strata, or layers. This indicates there was a rise in sea level long ago, she said.

"As the land surface was flooded [as sea levels rose], sediments were laid down progressively inland," McNamara said.

In 1393, an arch leading to the 150-foot-tall (45 meters) sea stack collapsed during a storm, according to Dunbriste.com. This may explain why it was named Dún Briste, which is Gaelic for "broken fort," according to the website.

In 2016, daredevil Iain Miller climbed the cliff, according to the Daily Express, a news outlet in the United Kingdom. That's the first time a person had set foot on top of the sea stack since 1990, when a group of climbers summited the stack, the Daily Express reported.

Before that, a team of scientists helicoptered to the top of Dún Briste in the 1980s. They reportedly found the remains of a medieval house and a broken quern stone, that is, a stone used for grinding corn, according to Castlebar News, a news publication in west Ireland.

(Laura Geggel / LIVE SCIENCE Senior Writer, February 15, 2018, https://www.livescience.com/61769-dun-briste-sea-stack-reddit.html?utm_source=ls-newsletter&utm_medium=email&utm_campaign=20180215-ls)

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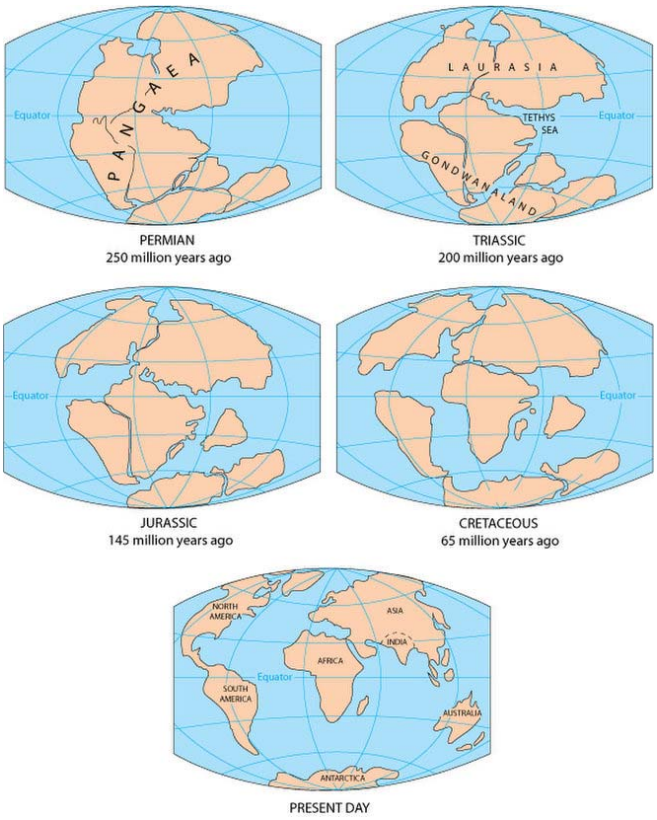
Facts About Pangaea, Ancient Supercontinent

About 300 million years ago, Earth didn't have seven continents, but instead one massive supercontinent called Pangaea, which was surrounded by a single ocean called Panthalassa.

The explanation for Pangaea's formation ushered in the modern theory of plate tectonics, which posits that the

Earth's outer shell is broken up into several plates that slide over Earth's rocky shell, the mantle.



The breakup of the Pangaea supercontinent.

Over the course of the planet's 3.5 billion-year history, several supercontinents have formed and broken up, a result of churning and circulation in the Earth's mantle, which makes up most of planet's volume. This breakup and formation of supercontinents has dramatically altered the planet's history.

"This is what's driven the entire evolution of the planet through time. This is the major backbeat of the planet," said Brendan Murphy, a geology professor at the St. Francis Xavier University, in Antigonish, Nova Scotia.

History

More than a century ago, the scientist Alfred Wegener proposed the notion of an ancient supercontinent, which he named Pangaea (sometimes spelled Pangea), after putting together several lines of evidence.

The first and most obvious was that the "continents fit together like a tongue and groove," something that was quite noticeable on any accurate map, Murphy said. Another telltale hint that Earth's continents were all one land mass comes from the geologic record. Coal deposits found in Pennsylvania have a similar composition to those spanning across Poland, Great Britain and Germany from the same time period. That indicates that North America and Europe must have once been a single landmass. And the orientation of magnetic minerals in geologic sediments reveals how Earth's magnetic poles migrated over geologic time, Murphy said.

In the fossil record, identical plants, such as the extinct seed fern *Glossopteris*, are found on now widely disparate continents. And mountain chains that now lie on different continents, such as the Appalachians in the United States and the Atlas Mountains in Morocco, were all part of the Central Pangaea Mountains, formed through the collision of the supercontinents Gondwana and Laurussia.

Pangaea formed through a gradual process spanning a few hundred million years. Beginning about 480 million years ago, a continent called Laurentia, which includes parts of North America, merged with several other micro-continents to form Euramerica. Euramerica eventually collided with Gondwana, another supercontinent that included Africa, Australia, South America and the Indian subcontinent.

About 200 million years ago, the supercontinent began to break up. Gondwana (what is now Africa, South America, Antarctica, India and Australia) first split from Laurasia (Eurasia and North America). Then about 150 million years ago, Gondwana broke up. India peeled off from Antarctica, and Africa and South America rifted, according to a 1970 article in the Journal of Geophysical Research. Around 60 million years ago, North America split off from Eurasia.

Life and climate

Having one massive landmass would have made for very different climatic cycles. For instance, the interior of the continent may have been utterly dry, as it was locked behind massive mountain chains that blocked all moisture or rainfall, Murphy said.

But the coal deposits found in the United States and Europe reveal that parts of the ancient supercontinent near the equator must have been a lush, tropical rainforest, similar to the Amazonian jungle, Murphy said. (Coal forms when dead plants and animals sink into swampy water, where pressure and water transform the material into peat, then coal.)

"The coal deposits are essentially telling us that there was plentiful life on land," Murphy told Live Science.

Climate models confirm that the continental interior of Pangaea was extremely seasonal, according to a 2016 article in the journal Palaeogeography, Palaeoclimatology, Palaeoecology. The researchers in this study used biological and physical data from the Moradi Formation, a region of layered paleosols (fossil soils) in northern Niger, to reconstruct the ecosystem and climate during the time period when Pangaea existed. Comparable to the modern-day African Namib Desert and the Lake Eyre Basin in Australia, the climate was generally arid with short, recurring wet periods that occasionally included catastrophic flash floods.

Pangaea existed for 100 million years, and during that time period several animals flourished, including the Traversodontidae, a family of plant-eating animals that includes the ancestors of mammals.

During the Permian period, insects such as beetles and dragonflies flourished. But the existence of Pangaea overlapped with the worst mass extinction in history, the Permian-Triassic (P-TR) extinction event. Also called the Great Dying, it occurred around 252 million years ago and caused most species on Earth to go extinct. The early Triassic period saw the rise of archosaurs, a group of animals that eventually gave rise to crocodiles and birds, and a plethora of reptiles. And about 230 million years ago some of the earliest dinosaurs emerged on Pangaea, including theropods, largely carnivorous dinosaurs that mostly had air-filled bones and feathers similar to birds.

Cycle in history

The current configuration of continents is unlikely to be the last. Supercontinents have formed several times in Earth's history, only to be split off into new continents. Right now for instance, Australia is inching toward Asia, and the east-

ern portion of Africa is slowly peeling off from the rest of the continent.

Geologists have noticed that there is a quasi-regular cycle in which supercontinents form and break up every 300 to 400 million years, but exactly why is a mystery, Murphy said. But most scientists believe that the supercontinent cycle is largely driven by circulation dynamics in the mantle, according to a 2010 article in the Journal of Geodynamics.

Beyond that, the details get fuzzy. While the heat formed in the mantle likely comes from the radioactive decay of unstable elements, such as uranium, scientists don't agree on whether there are mini-pockets of heat flow within the mantle, or if the entire shell is one big heat conveyor belt, Murphy said.

Current research

Scientists have created mathematical, 3D simulations to better understand the mechanisms behind continental movement. In a 2017 article in Geoscience Frontiers, scientists Masaki Yoshida and M. Santhosh explain how they produced simulations of large-scale continental movements since the breakup of Pangaea 200 million years ago. The models show how tectonic plate motion and mantle convection forces worked together to break apart and move large land masses. For example, Pangaea's large mass insulated the mantle underneath, causing mantle flows that triggered the initial breakup of the supercontinent. Radioactive decay of the upper mantle also raised the temperature, causing upward mantle flows that broke off the Indian subcontinent and initiated its northern movement.

Yoshida and Santos created additional geological models to predict mantle convection and continental movement patterns 250 million years in the future. These models suggest that over millions of years, the Pacific Ocean will close as Australia, North America, Africa, and Eurasia come together in the Northern Hemisphere. Eventually, these continents will merge, forming a supercontinent called "Amasia." The two remaining continents, Antarctica and South America, are predicted to remain relatively immobile and separate from the new supercontinent.

Additional reporting by Carol Stoll, Live Science contributor

Additional resources

- ClassZone: Animation of the breakup of Pangaea
- U.S. Geological Survey: This Dynamic Earth: The Story of Plate Tectonics
- Cornell University: Move the Continents! Interactive puzzle

(Tia Ghose, Associate Editor / Live Science, February 22, 2018, https://www.livescience.com/38218-facts-about-pangaea.html)

What is Gondwana?

Gondwana was an ancient supercontinent that broke up about 180 million years ago. The continent eventually split into landmasses we recognize today: Africa, South America, Australia, Antarctica, the Indian subcontinent and the Arabian Peninsula.

The familiar continents of today are really only a temporary arrangement in a long history of continental movement. Landmasses on Earth are in a constant state of slow motion, and have, at multiple times, come together as one. These all-in-one supercontinents include Columbia (also known as Nuna), Rodinia, Pannotia and Pangaea (or Pangea).

Gondwana was half of the Pangaea supercontinent, along with a northern supercontinent known as Laurasia.

The creation of Gondwana

Gondwana's final formation occurred about 500 million years ago, during the late Ediacaran Period. By this time, multicellular organisms had evolved, but they were primitive: The few fossils left from this period reveal segmented worms, frond-like organisms and round creatures shaped like modern jellyfish.

In this world, Gondwana conducted its slow grind to supercontinent status. Bits and pieces of the future supercontinent collided over millennia, bringing together what are now Africa, India, Madagascar, Australia and Antarctica.

This early version of Gondwana joined with the other landmasses on Earth to form the single supercontinent Pangaea by about 300 million years ago. About 280 million to 230 million years ago, Pangaea started to split. Magma from below the Earth's crust began pushing upward, creating a fissure between what would become Africa, South America and North America.

As part of this process, Pangaea cracked into a northernmost and southernmost supercontinent. The northern landmass, Laurasia, would drift north and gradually split into Europe, Asia and North America.

The southern landmass, still carrying all those bits and pieces of the future southern hemisphere, headed southward after the split. This supercontinent was Gondwana.

Gondwana's breakup

During Gondwana's stint as the southerly supercontinent, the planet was much warmer than it was today — there was no Antarctic ice sheet, and dinosaurs still roamed the Earth. By this time, it was the Jurassic Period, and much of Gondwana was covered with lush rainforest.

The great supercontinent was still under strain, however. Between about 170 million and 180 million years ago, Gondwana began its own split, with Africa and South America breaking apart from the other half of Gondwana. About 140 million years ago, South America and Africa split, opening up the South Atlantic Ocean between them. Meanwhile, on the eastern half of the once-supercontinent, Madagascar made a break from India and both moved away from Australia and Antarctica.

Australia and Antarctica clung together longer; in fact, Antarctica and Australia didn't make their final split until about 45 million years ago. At that point, Antarctica started to freeze over as Earth's climate cooled, while Australia drifted northward. (Today, the Australian continent still moves north at a rate of about 1.2 inches (3 centimeters) a year.)

Gondwana theory

The exact mechanisms behind Gondwana's split are still unknown. Some theorists believe that "hot spots," where magma is very close to the surface, bubbled up and rifted the supercontinent apart. In 2008, however, University of London researchers suggested that Gondwana instead split into two tectonic plates, which then broke apart.

The existence of Gondwana was first hypothesized in the mid-1800s by Eduard Suess, a Viennese geologist who dubbed the theoretical continent "Gondwanaland." Suess was tipped off by similar fern fossils found in South America, India and Africa (the same fossils would later be found in Antarctica). At the time, plate tectonics weren't understood, so Suess didn't realize that all of these continents had once been in different locations. Instead, he developed a theory of sea level rise and regression over time that would have linked together the southern hemisphere continents with land bridges.

Suess got the name Gondwanaland from the Gondwana region of central India, where geological formations match those of similar ages in the southern hemisphere.

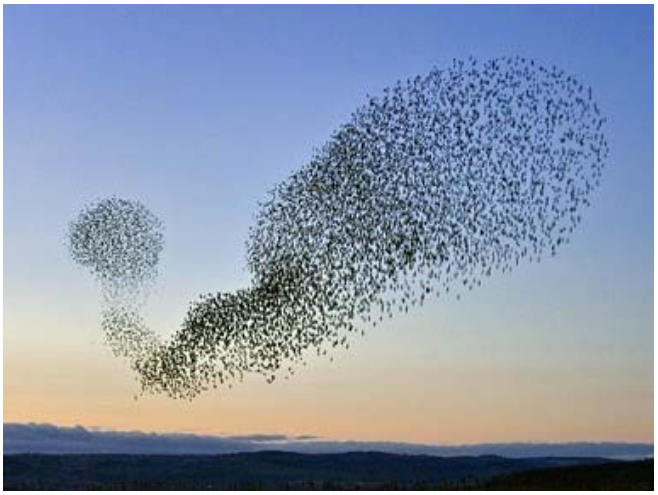
(Stephanie Pappas / Live Science Contributor, June 7, 2013, https://www.livescience.com/37285-gondwana.html)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΠΕΡΙΒΑΛΛΟΝ

Murmuration

Το φαινόμενο αυτό αποτυπώθηκε φωτογραφικά πριν από 2 χρόνια σε ένα ποτάμι της Ιρλανδίας από τη Sophie και τη Liberty, είναι σκηνοθέτιδες ντοκιμαντέρ φυσικής ιστορίας. Αποκαλείται **Murmuration** και δεν υπάρχει ακριβής ελληνική λέξη για να το περιγράψη. Σμήνη ψαρονιών πετάνε με έναν τόσο οργανωμένο τρόπο που ξεπερνά τον ανθρώπινο νου.

Το πώς τα πουλιά οργανώνονται και πετούν σε τέτοιο σχηματισμό, δεν έχει απαντηθή ακόμα. Μια μάλλον απλοϊκή εξήγηση είναι το ότι κάθε πουλί μιμείται την κίνηση ενός άλλου και πετά προς την ίδια κατεύθυνση.



Το ίδιο φαινόμενο καταγράφει ένα εντυπωσιακό βίντεο του National Geographic THE ART OF FLYING, που μπορείτε να δείτε εδώ: https://video.nationalgeographic.com/video/short-film-showcase/flight-of-the-starlings-watch-this-eerie-but-beautiful-phenomenon?-starlingsnative&sf57780463=1

Είχα την τύχη να παρακολουθήσω πριν χρόνια κι' εγώ ένα παρόμοιο φαινόμενο, κατά το σούρουπο, στην περιοχή του αεροδρομίου Πρεβέζης, και μου το θύμισε ο φίλος, που μου έστειλε τις παραπάνω φωτογραφίες. Τα ψαρόνια πετούσαν σε κοπάδια σαν αρμονικά μεταβαλλόμενα κύματα, μέχρι που κούρνιαξαν στα ψηλά δένδρα της περιοχής, μόλις χάθηκε ο ήλιος στον ορίζοντα. Ήταν ένα μαγικό θέαμα!!!

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΛΟΙΠΑ

The Author of This Physics Paper Is 7 Years Old (and Also a Cat)

On April 1, 2014, the American Physical Society announced a landmark change in policy: All scientific papers authored by cats would henceforth become freely available to the public.

The announcement was a joke (it was April Fools' Day), but the cat that inspired it was not. His name is Chester — better known to the scientific community as F.D.C. Willard, arguably the most famous cat in physics after Schrödinger's.

In 1975, Chester/Willard's name appeared alongside Michigan State University physics professor Jack Hetherington's on an influential paper about the low-temperature physics of helium-3 isotopes — versions of an element (helium, in this case) with different numbers of neutrons in their nuclei — published in the journal Physical Review Letters. Hetherington was Chester's owner, and he had initially included the 7-year-old Siamese cat's name on the paper to resolve a grammatical blunder.

As a colleague pointed out while editing the draft, Hetherington listed himself as the study's sole author, yet he had nevertheless written the entire paper using the "we" pronoun. This was against the journal's style rules, the colleague noted. Hetherington's paper would surely be rejected if it wasn't retyped.

Hetherington, however, was eager to submit his work. "Changing the paper to the impersonal seemed too difficult now that it was all written and typed," Hetherington said in the book "More Random Walks in Science" (CRC Press, 1982). "Therefore, after an evening's thought, I simply asked the secretary to change the title page to include the name of the family cat."

Of course, Chester's name was too well known to Hetherington's friends and colleagues, so an alias would be necessary. He settled on F.D.C. Willard — F.D.C. being an acronym for Felis Domesticus Chester, and Willard being the name of Chester's tomcat father.

And so, on Nov. 24, 1975, the paper co-authored by Hetherington and his cat was published in the 35th issue of Physical Review Letters.

Many of Hetherington's colleagues knew about the ruse, it turned out, and few seemed to care. Michigan State's physics department head, for one, embraced the feline deception. "The chairman… was able to inflate some statistic requested by the administration by including Willard among the published authors from the Physics department," Hetherington wrote in a letter. "I'm not sure if it helped or hindered my own grant-getting efforts."

Chester's true identity was ultimately revealed when a student went looking for Hetherington with a question about the paper; when Hetherington couldn't be found, the student asked to speak with Willard instead. "Everyone laughed and soon the cat was out of the bag," Hetherington wrote.

Chester the cat subsequently retired from science, but his alias took on a life of its own. Several years later, a French paper on helium-3 appeared in the journal La Recherche under a single author's name: F.D.C. Willard. (Apparently, Hetherington wrote, the actual research team could not agree on a version of the paper that satisfied them all, so they decided to credit America's best-published cat instead.)

As of today, Chester's paper on helium-3 has been cited more than 50 times, and a menagerie of nonhuman study authors have followed in his formidable paw-steps. In 1978, immunologist and apparent "Lord of The Rings" fan Polly Matzinger co-authored a paper with one Galadriel Mirkwood — the nickname of her trusty Afghan hound. More recently, in 2001, a paper on gyroscopes authored by A.K. Geim and H.A.M.S. ter Tisha appeared in the journal Physica B: Condensed Matter. Geim won a Nobel Prize in 2010 for co-discovering graphene. Tisha was his pet hamster.

(Brandon Specktor, Senior Writer / LIVESCIENCE, February 8, 2018, https://www.livescience.com/61698-cat-authors-physics-paper.html?utm_source=ls-newsletter&utm_medium=email&utm_campaign=20180208-ls)

ΗΛΕΚΤΡΟΝΙΚΑ ΠΕΡΙΟΔΙΚΑ

www.geoengineer.org

Κυκλοφόρησε το Τεύχος #153 του **Newsletter** του **Geoengineer.org** (Φεβρουαρίου 2018) με πολλές χρήσιμες πληροφορίες για όλα τα θέματα της γεωμηχανικής. Υπενθυμίζεται ότι το Newsletter εκδίδεται από τον συνάδελφο και μέλος της ΕΕΕΕΓΜ Δημήτρη Ζέκκο (secretariat@geoengineer.org).

Ενδεικτικά αναφέρονται:

- Landslide hits a bus in Colombia, killing 13
- The ISSMGE International Journal of Geoengineering Case Histories announces its Social Media Presence
- Bridge collapses in Colombia killing at least nine (video)
- FHWA publishes research report on Spread Footings for Highway Bridges
- California gets hit by deadly mudslides
- Singapore's deepest transmission cable tunnel system is almost ready
- Huge crack spreading on Washington's Rattlesnake Ridge prompts evacuations (video)
- Final Investigative Report Explaining The Orroville Dam Spillway Damage in February 2017 Released
- 75,000 people evacuated as Mount Mayon volcano erupts in Philippines (video)

http://campaign.r20.constantcontact.com/render?m=1101304736672&ca=5bf6a1d4-e8d4-4a23-9f5a-746955479aad

https://www.icevirtuallibrary.com/toc/jgein/25/1

Κυκλοφόρησε το Τεύχος 1 του Τόμου 25 του περιοδικού GEOSYNTHETICS INTERNATIONAL με τα παρακάτω περιεχόμενα:

Experimental evaluation of geomembrane/geotextile interface as base isolating system, V. Kalpakcı, A. T. Bonab, M. Y. Özkan, Z. Gülerce, 25(1), pp. 1–11

Serviceability state deformation behaviour of two-tiered geosynthetic reinforced soil walls, C. Yoo, 25(1), pp. 12–25

Performance evaluation of full-scale geosynthetic reinforced flexible pavement, Q. Chen, S. Hanandeh, M. Abu-Farsakh, L. Mohammad, 25(1), pp. 26–36

Geosynthetic reinforcement of pile-supported embankments, R. Girout, M. Blanc, L. Thorel, D. Dias, 25(1), pp. 37–49

Practical approach to predict the shear strength of fibre-reinforced clay, M. Mirzababaei, M. Mohamed, A. Arulrajah, S. Horpibulsuk, V. Anggraini, 25(1), pp. 50–66

Methodology to evaluate hydraulic compatibility of geotextile and RCA in underdrain systems, A. Abbaspour, B. F. Tanyu, A. H. Aydilek, A. Y. Dayioglu, 25(1), pp. 67–84

Durability of reinforced PVC-P geomembranes installed in reservoirs in eastern Spain, M. Blanco, N. Touze-Foltz, M. Pérez Sánchez, M. Redon-Santafe, F. J. Sánchez Romero, J. B. Torregrosa Soler, F. A. Zapata Raboso, 25(1), pp. 85–97

Long-term response and design of two geosynthetics: effect of field installation damage, M. Pinho-Lopes, A. M. Paula, M. L. Lopes, 25(1), pp. 98–117

https://www.sciencedirect.com/journal/geotextiles-and-geomembranes/vol/46/issue/1

Κυκλοφόρησε το Τεύχος 1 του Τόμου 46 του περιοδικού Geotextiles and Geomembranes με τα παρακάτω περιεχόμενα:

Strength characteristics of soilbags under inclined loads, Si-Hong Liu, Fan Jia, Chao-Min Shen, Li-Ping Weng, Pages 1-10

Centrifuge modeling of the geotextile reinforced slope subject to drawdown, Fangyue Luo, Ga Zhang, Yang Liu, Changhui Ma, Pages 11-21

Laboratory and numerical modeling of strip footing on geotextile-reinforced sand with cement-treated interface, Ahad Ouria, Arsam Mahmoudi, Pages 29-3

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