Εύβοια. Ο εξωγήινος στον Κάβο Ντόρο…
(Γιάννης Τούντας)

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ΕΠΙΣΤΗΜΟΝΙΚΗ
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& ΓΕΩΤΕΧΝΙΚΗΣ
ΜΗΧΑΝΙΚΗΣ

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(Μπάλος, Χανιά)

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Αρ. 59 – ΙΟΥΛΙΟΣ 2013

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Άρθρα 3
- Man-Made Earthquakes 3
- 4 Hot Trends in Civil Structures and Dam Safety 5
- Alternative ground control strategies in underground construction 8

Περιλήψεις προσφάτως υποστηριχθεισών Διδακτορικών Διατριβών: Έλενα Καπόγιαννη " Αναλυτική, Πειραματική και Υπολογιστική Διερεύνηση Οπλισμένων Πρανών έναντι Στατικής και Σεισμικής Φόρτισης " 19

Τιμητικές Διακρίσεις Ελλήνων Γεωμηχανικών και Γεωεπιστημόνων 23
- Γιάννης Αναστασόπουλος 23
- Δημήτρης Καραμήτρος 23
- Κωνσταντίνος Λουπασάκης 23
- Βασίλης Μαρίνος 23
- Κώστας Σαχπάζης 23

Θέσεις εργασίας για γεωεπιστήμονες: Πολυτεχνείο Κρήτης – Ερευνητικό Πρόγραμμα «ΘΑΛΗΣ» 24

Νέα από τις Ελληνικές και Διεθνείς Γεωτεχνικές Ενώσεις: Geoworld Technical Forums 25

Εθνικό Κέντρο Τεκμηρίωσης 26

Προσεχείς Εκδηλώσεων Γεωτεχνικού Ενδιαφέροντος στην Ελλάδα 28
- 2ο Πανελλήνιο Συνέδριο Φραγμάτων και Ταμιευτήρων 28
- 6ο Πανελλήνιο Συνέδριο Λιμενικών Έργων 29
- 2nd Eastern European Tunnelling Conference 29

Προσεχείς Γεωτεχνικές Εκδηλώσεις: 30
- GeoME 2013 6th International Conference GEOSYNTHETICS Middle East 30
- Workshop Dams: Incidents and Accidents – What Can We Learn?" 31
- ASIA 2014 Fifth International Conference on Water Resources and Hydropower Development in Asia 31
- ICITG 2014 Second International Conference on Information Technology in Geo-Engineering 32
- 9th International Conference on Structural Analysis of Historic Constructions 33
- International Congress on Environmental Geotechnics 34
- Innovative Geotechnics for Africa 34
- Workshop on Volcanic Rocks & Soils 35

Ενδιαφέροντα Γεωτεχνικά Νέα 37
- Sinkholes: When the Earth Opens Up 37
- Plan to build world's longest undersea tunnel from Dalian to Yantai 41
- Κάστορες σώζουν ρωσικό χωριό από την έλλειψη νερού 42

Ενδιαφέροντα – Σεισμοί 44
- Αντιμέτωπα με τη διάβρωση, τα ψηλά βουνά κρατούν το ανάστημά τους 44
- Predicting earthquakes and saving lives - with smartphones 44
- NASA says new technology could help buildings survive earthquakes (video) 47
- Η διάρκεια του 24ωρου αλλάζει από το λόξυγκα της Γης 47
- Τα ηφαίστεια «ουρλιάζουν»! Παράγουν θορύβους από γεωλογικές διεργασίες που σημειώνονται πριν από μια έκρηξη 48
- Natural Disasters at All-Time High in China: Earthquakes taking a commanding lead in causing damage and economic losses 49
- John Milne: Isle of Wight's earthquake science pioneer 50

Ενδιαφέροντα - Λοιπά 52
- 25 of mankind's greatest engineering achievements 52
- Οι έρημοι του πλανήτη πρασινίζουν χάρη στη "γονιμοποίηση από διοξείδιο του άνθρακα" 57
- Δράμα: Ανασκαφή φέρνει στο φως το χαμένο παρελθόν μιας απέραντης σαβάνας ηλικίας 9 εκατ. ετών 58
- Fracking Could Help Geothermal Become a Power Player 59
- Notable failures in U.S. infrastructure in recent years 60

Νέες Εκδόσεις στις Γεωτεχνικές Επιστήμες 62

Ηλεκτρονικά Περιοδικά 64

Man-Made Earthquakes

The number of earthquakes has increased dramatically over the past few years within the central and eastern United States. More than 300 earthquakes above a magnitude 3.0 occurred in the three years from 2010-2012, compared with an average rate of 21 events per year observed from 1967-2000.

This increase in earthquakes prompts two important questions: Are they natural, or man-made? And what should be done in the future as we address the causes and conesquences of these events to reduce associated risks? USGS scientists have been analyzing the changes in the rate of earthquakes as well as the likely causes, and they have some answers.

USGS scientists have found that at some locations the increase in seismicity coincides with the injection of wastewater in deep disposal wells. Much of this wastewater is a by-product of oil and gas production and is routinely disposed of by injection into wells specifically designed and approved for this purpose.

Review Article on Injection-Induced Earthquakes

U.S. Geological Survey geophysicist William Ellsworth reviewed the issue of injection-induced earthquakes in a recent study published in the journal *Science*. The article focused on the injection of fluids into deep wells as a common practice for disposal of wastewater, and discusses recent events and key scientific challenges for assessing this hazard and moving forward to reduce associated risks.

What is Induced Seismicity?

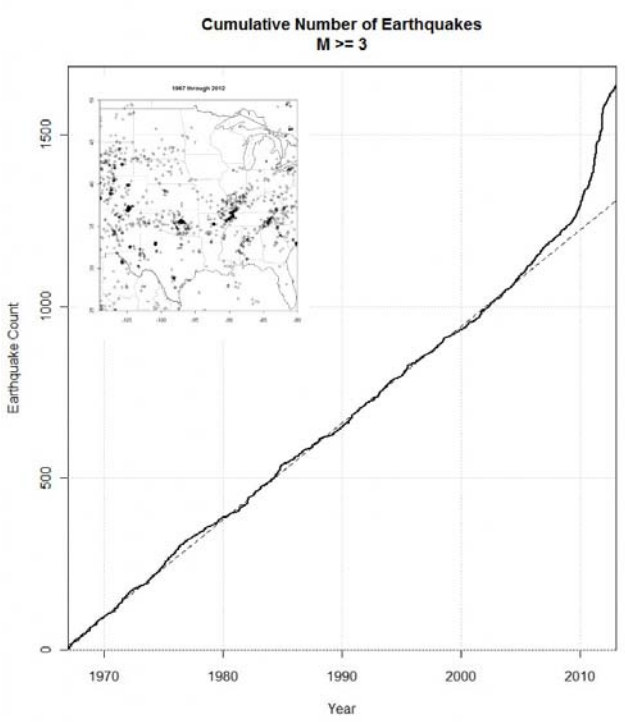
Although it may seem like science fiction, man-made earthquakes have been a reality for decades. It has long been understood that earthquakes can be induced by impoundment of water in reservoirs, surface and underground mining, withdrawal of fluids and gas from the subsurface, and injection of fluids into underground formations.

What is Wastewater Disposal?

Water that is salty or polluted by chemicals needs to be disposed of in a manner that prevents it from contaminating freshwater sources. Often, it is most economical to geologically sequester such wastewaters by injecting them underground, deep below any aquifers that provide drinking water.

Wastewater can result from a variety of processes related to energy production. For example, water is usually present in rock formations containing oil and gas and therefore will be co-produced during oil and gas production. Wastewater can also occur as flow back from hydraulic fracturing operations that involve injecting water under high pressure into a rock formation to stimulate the movement of oil and gas to a well for production.

When wastewater disposal takes place near faults, and underground conditions are right, earthquakes may be more likely to occur, Ellsworth's research showed. Specifically, an earthquake can be triggered by the well-understood mechanism of raising the water pressure inside a fault. If the pressure increases enough, the fault may fail, releasing stored tectonic stress in the form of an earthquake. Even faults that have not moved in millions of years can be made to slip and cause an earthquake if conditions underground are right.



Cumulative count of earthquakes with a magnitude ≥ 3.0 in the central and eastern United States, 1967–2012. The dashed line corresponds to the long-term rate of 21.2 earthquakes per year, with an increase in the rate of earthquake events starting around 2009.

While the disposal process has the potential to trigger earthquakes, not every wastewater disposal well produces earthquakes. In fact, very few of the more than 30,000 wells designed for this purpose appear to cause earthquakes.

Hydraulic Fracturing

Many questions have been raised about whether hydraulic fracturing — commonly known as "fracking"— is responsible for the recent increase of earthquakes. USGS's studies suggest that the actual hydraulic fracturing process is only very rarely the direct cause of felt earthquakes. While hydraulic fracturing works by making thousands of extremely small "microearthquakes," they are rarely felt and are too small to cause structural damage. As noted previously, wastewater associated with hydraulic fracturing has been linked to some, but not all, of the induced earthquakes.

Unknowns and Questions Moving Forward

USGS scientists are dedicated to gaining a better understanding of the geological conditions and industrial practices associated with induced earthquakes, and to determining how seismic risk can be managed.

One risk-management approach highlighted in Ellsworth's article involves the setting of seismic activity thresholds for safe operation. Under this "traffic-light" system, if seismic activity exceeds preset thresholds, reductions in injection would be made. If seismicity continued or escalated, operations could be suspended.

The current regulatory framework for wastewater disposal wells was designed to protect drinking water sources from contamination and does not address earthquake safety. Ellsworth noted that one consequence is that both the quantity and timeliness of information on injection volumes

and pressures reported to the regulatory agencies is far from ideal for managing earthquake risk from injection activities.

House damage in central Oklahoma from the magnitude 5.6 earthquake on Nov. 6, 2011. Research conducted by USGS geophysicist Elizabeth Cochran and her university-based colleagues suggests that this earthquake was induced by injection into deep disposal wells in the Wilzetta North field. Learn more about that research at: http://geology.gsapubs.org/content/early/2013/03/26/G34045.1.abstract. Photo Credit: Brian Sherrod, USGS.

Thus, improvements in the collection and reporting of injection data to regulatory agencies would provide much-needed information on conditions potentially associated with induced seismicity. In particular, said Ellsworth, daily reporting of injection volumes, and peak and average injection pressures would be a step in the right direction, as would measurement of the pre-injection water pressure and tectonic stress.

Importance of Understanding Hazards and Risks

There is a growing interest in understanding the risks associated with injection-induced earthquakes, especially in the areas of the country where damaging earthquakes are rare.

Oilfield waste arrives by tanker truck at a wastewater disposal facility near Platteville, Colo. After removal of solids and oil, the wastewater is injected into a deep well for permanent storage underground. This disposal process has the potential to trigger earthquakes, but very few wastewater disposal wells produce earthquakes. No earthquakes are associated with injection at the site in this photograph. Photo taken on Jan. 15, 2013. Photo Credit: William Ellsworth, USGS

For example, wastewater disposal appears to have induced the magnitude-5.6 earthquake that struck rural central Oklahoma in 2011, leading to a few injuries and damage to more than a dozen homes. Damage from an earthquake of this magnitude would be even worse if it were to happen in a more densely populated area.

Start with Science

As the use of injection for disposal of wastewater increases, the importance of knowing the associated risks also grows. To meet these challenges, the USGS hopes to increase research efforts to understand the causes and effects of injection-induced earthquakes.

More Information

The USGS has FAQs online that provide additional details and background on induced seismicity. You can also learn more by reading a story by the Department of the Interior on this topic.

(http://www.usgs.gov/blogs/features/usgs_top_story/man-made-earthquakes/?from=title)

4 Hot Trends in Civil Structures and Dam Safety

As more dams are constructed, more questions, topics and trends come along with them. Currently, managing aging infrastructure, using new technology, managing risk, and dealing with seismic issues are concerning and exciting dam owners and operators worldwide.

Dams serve as the lifeblood of communities and cities, helping to provide water for commercial and domestic use, irrigate agricultural land, and provide fuel for hydroelectric facilities. Advancement occurs every day in the design, construction and operation of dams and associated civil structures. In this article, we remind readers of the important roles dams play throughout the world, as well as provide a glimpse of some of the critical topics that are top-of-mind among the world's top civil experts.

Role of dams in today's world

According to the International Commission on Large Dams' (ICOLD) World Register of Dams (a non-comprehensive database created in 1958 as a resource on dams around the world, last updated in 2011), the demand for water as a natural resource is increasing internationally, with the potential to grow 2-3% per year over the coming decades.

"It is agreed today within the international community that there is a necessity to promote and ensure progress in water storage to address the world's challenges related to water security and global change," says Enrique Cifres, chairman of the ICOLD Dams and River Basin Management Committee. "Since 2000, [the industry] has seen a new impetus in promoting new infrastructure to meet the needs of countries in terms of water supply, energy and food, as well as the need to address the increasing occurrence of large floods and drought."

Dams are major players in meeting this demand, currently contributing an aggregate storage of 1.5 million hectares of water. To continue to meet the growing need for water, more dams need to be constructed to compensate for growing populations, seasonal variance and unevenly distributed water resources.

According to Cifres, the current trend of new growth is strong in developing countries "where local conditions allow funding from multilateral agencies." This along with increased new development in Europe and Asia is setting the pace for future development.

Purposes and use

Based on the 37,461 dams included in the World Register on Dams, the largest percentage of single-purpose dams, which make up more than 70% of dams worldwide, are designed for irrigation, providing a valuable asset to agricultural and rural regions. The second largest use (18%) of single-purpose dams is to impound water for hydroelectric power generation. Other smaller categories of use include water supply, flood control, recreation, navigation and fish farming.

In contrast, multi-purpose dams provide a more balanced distribution of purposes, with 24% being used for irrigation, 20% for flood control, 17% for water supply, and 16% for hydropower, among other uses. While they achieve a wider range of purposes, the number of multipurpose dams (9,321) is much smaller than that of single-purpose dams (26,938).

Geographical distribution

The USA boasts the largest number of dams in the register (9,265), with China and India following behind with 5,191 and 5,101, respectively. Japan ranks in the top four with 3,076. Canada, a country that produces the majority of its electricity using hydropower facilities, has 1,166 dams in the register. Also notable within the top ten are South Africa (1,114), Spain (987), Turkey (741), Brazil (684) and France (622). The countries with the smallest number of dams are Nepal, Latvia and Luxembourg with three apiece.

Type, size, capacity, and age

The main types of dams listed within the ICOLD register are earth, rock fill, gravity, buttress, barrage, arch and multiple arch. These types are widely distributed throughout the world. The highest of these dams (by type) are Rogun (earth and rock fill) in Tajikistan at 335 meters, Grande Dixence (gravity) in Switzerland at 285 meters, Itaipu (buttress) on the border of Brazil and Paraguay at 196 meters, Tongzihao (barrage) in China at 53 meters, Bakhtiyari (arch) in Iran at 315 meters and Deriner (multiple arch) in Turkey at 249 meters.

The register also classifies dams by spillway and reservoir capacity. According to Cifres, "records on height, installed power, discharges, etc. are reached continuously."

In spillway capacity, India boasts the largest projects with Nagarjunasagar Tail Pond (1,600,000 m^3/s), Ukai Dam (1,125,000 m^3/s), the Mid Manair Project (508,000 m^3/s), Mohini Pick-up Weir (265,400 m^3/s), and Maudaha (111,328 m^3/s) all in the top six. China also ranks high in this category with Sanxia Dam, which has a spillway capacity of 124,300 m^3/s. Rounding off the top 10 are Brazil's Tucurui with 100,000 m^3/s, the Democratic Republic of Congo's Inga II dam with 96,000 m^3/s, Canada's Kootenay Canal with 95,600 m^3/s, and Paraguay and Argentina's Yacyreta with 95,000 m^3/s.

Three Gorges Dam is a larger-than-life example of the colossal impact civil works and hydropower generation have on a particular region.

In terms of the size of a dam, reservoir capacity is an additional vital measurement. The three largest dams with regard to reservoir capacity are Kariba in Zimbabwe/Zambia with 180.6 billion m^3, Bratsk dam in Russia with 169 billion

m^3, and High Aswan dam in Egypt with 162 billion m^3. The top 10 show incredible regional diversity, including dams from Ghana (Kpong Dam/Dykes and Akosombo Dam), Canada (Daniel Johnson Dam, Manic 5 and Bennett W.A.C), Russia (Krasnoyarsk Dam and Zeya Dam), and Brazil (Lajeado Dam).

Well-built dams are known for being able to stand the test of time, and a number of dams in Spain, Japan and India have proven the long-term value of dams. Proserpina in Spain was construction in AD 130, with an age of 1,883 years. Japan boasts 10 dams considered to be some of the oldest in the world, ranging from 885 to 1,613 years. India's Thonnur Tank dam is also one of the oldest with an age of 1,013 years.

Installed hydroelectric power capacity

A considerable percentage of large dams impound water for hydroelectric power generation. Some of the largest dams in the world also produce the most electricity. The final generating unit at Three Gorges Dam on the Yangtze River in China was completed and brought online in 2012. This colossal project has an installed capacity of 22,500 MW, making it the largest hydroelectric plant in terms of capacity in the world.

While it is smaller in terms of capacity with 14,000 MW, Itaipu Dam on the Parana River in Brazil and Paraguay actually produces more electricity annually than Three Gorges (98.3 TWh compared to 98.1 TWh). Other top plants in terms of capacity include 12,630 MW Sanxia, 12,600 MW Wangjiahe and 12,600 MW Xiluodu in China. Guri hydropower project on the Caroni River (10,200 MW/53.41 TWh) in Venezuela, the Tucurui project on the Tocantins river in Brazil (8,370 MW/41.43 TWh), and Grand Coulee Dam on the Columbia River in the USA (6,809 MW/20 Twh) also boast large installed capacities.

Hot topics and trends

So what are the trends and topics currently being discussed with regard to dams and other civil structures?

With as many sources as there are out there to address this topic, there are probably just as many diverse answers.

One way to identify these trends is to examine the topics coming to the forefront at two international events: HydroVision International, held in July in Denver, Colorado, USA, and ICOLD's 81st Annual Meeting, held in August in Seattle, Washington, USA.

Conference content at these two events clearly points to a focus on four important trends:

Managing aging infrastructure

As the age of the world's infrastructure increases, additional technical approaches and strategies for managing and extending the life of these dams are essential, as is determining when and how to decommission dams when they reach the end of their lifespan, or if they can be successfully rehabilitated.

Both HydroVision Inter-national and the ICOLD meeting include sessions on this topic, demonstrating its current importance in the industry.

As the largest hydropower event in the world, HydroVision International has a wide range of tracks and sessions but focuses one entire seven-session track on the topic of Civil Works and Dam Safety. A number of the sessions at HydroVision International 2013 touched on this topic, including one regarding the importance of monitoring and maintaining gate operation and another identifying the factors that can impact and extend the useful life of a dam, primary causes of dam failure, and how to use risk-informed decision making on remedial projects. Technical papers were also presented on this topic, including case studies on repairs and modifications to extend the life of dams.

This topic is discussed at the one-day ICOLD Symposium: Changing Times: Infrastructure Development to Infrastructure Management, as well as during two ICOLD technical workshops. Technical approaches and strategies for managing aging infrastructure; new technology advances in dam safety; security, monitoring, and risk management; and sustainable hydropower development are all key components concerning dam owners and operators today that are being discussed at the ICOLD event.

Additionally, workshops are planned to cover the aging and life extension technologies for concrete dams, which indicates a growing need for knowledge and technological advances to keep these dams safe and operating reliably as they age.

Using new technology

Based on the discussion of challenges faced by dam owners and operators, the availability of new, state-of-the-art technology for dam, risk and levee management are essential to a constructive dialogue about the future of the Industry. Utilization of technology can help extend the life and efficacy of a dam, improve best practices for dam safety management, improve current practices in levee and embankment management, and provide seismic analysis to help manage embankment dams.

One HydroVision International presentation in particular discussed a method of using steel-rod breaking excitation to identify instability of tainter gates. Additional technical paper sessions cover the instrumentation and controls technology for dams with a hydroelectric component and total condition monitoring systems.

An ICOLD workshop also covers new technologies on an important topic: monitoring dams and levees. The discussion includes perspectives and case studies on the use of laser scanning, geophysical methods, and GPS for measurement; fiber optic temperature and strain sensing; as well as advances and improvements made on more traditional instruments and tools, such as piezometers.

Managing risks

While no owner likes to consider the damages and conesquences that follow a dam failure, the best safeguard is having all bases covered in case of a failure. This includes evaluating the construction and development; considering rehabilitation as a preventative measure; quantifying and identifying environmental impact, economic, and life losses; and handling insurance coverage. An important component of this process is also determining the real risk of a catastrophic event or dam failure, whether it be a mechanical fault or an external natural disaster such as an earthquake. From a technical perspective, identifying the importance of sound mechanics and failure mode analysis are also vital components in handling the possibility of dam failure.

The trends in this field are moving towards improved design techniques and monitoring during dam operation, according to Cifres. "The newest dam safety techniques are used to optimize the safety of the structure to minimize plant damages," in spite of the natural and unnatural forces placing them at risk.

Understanding the threats and being able to filter through predictions and forecasts is a vital component to a risk management plan, as seen by the emphasis placed on risk management at HydroVision International. Peter Amos of Damwatch Services in New Zealand took part in a panel presentation session to discuss just how real the risks can

be, how to analyze flood frequency and seismic hazard, as well as what to do with load uncertainty and the impacts such threats have on dam design.

An ICOLD workshop on risk-informed dam safety management sheds a light on how dam safety has transformed to rely on risk-informed decisions through examples from public and private dam safety regulators. This practical workshop focuses on how this concept is implemented and the difference it can make in protecting an asset. Dam safety is a major issue and one of the targeted goals determined by ICOLD, reflecting "the concern of society and thus, the dam engineering community" as well.

Addressing seismic issues

Seismic issues grow ever more important as we depend heavily on infrastructure for irrigation, flood control, hydropower and more. The threat of a dam collapse or cracks due to an earthquake or tremor is very real throughout the world and is one that must be planned for.

This concern was shared by the speakers at HydroVision International, particularly in regards to the grid stability of hydropower. As seismic events can damage dams and the hydroelectric plants that they power, the stability of the energy grid requires precautionary measures and constant seismic analysis. Additionally, probabilistic seismic hazard analysis was also discussed.

ICOLD addresses this concerning topic in a Technical Workshop format, with experts discussing the seismic analysis of embankment dams specifically. The workshop will break down the framework of seismic analysis and also discuss dynamic response analysis, liquefaction and post-earthquake stability through practical case study analysis and application.

Keeping up to date

The top concerns and topics of the industry can change as quickly as a river current. To stay up to date on what's happening in the industry, bookmark the Dams and Civil Structures Topic Center at http://www.HydroWorld.comwww.HydroWorld.com, where the news is updated daily to keep you informed and on top of the latest trends.

(Bethany Duarte / HRW-Hydro Review Worldwide, 1st July 2013, http://www.hydroworld.com/articles/print/volume-21/issue-4/articles/civil-works/4-hot-trends-in-civil-structures-and-dam-safety.html).

Alternative ground control strategies in underground construction

Evert Hoek, Evert Hoek Consulting Engineer Inc., Canada

ABSTRACT

Underground works vary from shallow urban tunnels to very deep tunnels and caverns in the world's great mountain ranges. The problems encountered at and between these extremes are entirely different and require appropriate approaches to site investigation, design and construction. The establishment of reliable financial estimates, construction schedules and contract proposals can only be done once a realistic geological model has been prepared and a clear understanding of the likely behaviour of the rock mass and the groundwater conditions has been established.

The conditions that control the behaviour of different kinds of excavations in a variety of geological environments are presented in the context of case histories. The aim is to provide project owners, financial managers, insurance companies and contractors with a road map that may assist them in avoiding some of the pitfalls and in considering some of the alternative strategies in the development of underground projects.

1 INTRODUCTION

Tunnels have been built for hundreds of years as part of transportation systems for people, goods, water and services. Until the middle of the last century these tunnels were generally small in size and the builders sought out the most favourable geology and topography in which to build them. With increasing population densities and growing international trade came the need for larger, longer and deeper tunnels through increasingly complex geological conditions. In addition, development of underground hydropower projects, gas and oil and dry goods storage facilities, as well as defence facilities, created a demand for large underground caverns, sometimes at considerable depth below surface. In parallel with these civil engineering projects, the mining industry has gradually moved toward deeper and larger underground operations with some gold mines in South Africa operating at depths of approximately 4 km below surface (Anonymous, 2011). In order to mine low grade deposits economically many underground mines employ mass mining techniques, such as block caving, in which the ore body is undercut and the ore drawn downward through ore-passes to extraction levels.

These advances have placed huge demands on the geologists and engineers who have to assemble the information and carry out the designs for the excavations required to meet the needs described above. Early texts on rock tunnelling (e.g. Terzaghi, 1946), while still useful for understanding some of the general concepts of tunnelling, are no longer appropriate for the design of many of underground excavations in use today or planned for tomorrow. In the following text an attempt is made to summarize the advances that have been made or which still have to be made to meet these challenges.

2 THE YACAMBÚ-QUIBOR TUNNEL IN VENEZUELA

2.1 Project background

The Yacambú-Quibor tunnel in the State of Lara in Venezuela will transfer water from the wet tropical Orinoco basin, on the eastern flank of the Andes, to the semi-arid Quibor valley on the western flank of the Andes. The agricultural and urban requirements of this semi-arid agricultural area, near the city of Barquisimeto, exceed currently available fresh water supplies and have resulted in a significant depletion of aquifers in the Quibor region.

The 4.0 m average internal diameter 24.3 kilometre long tunnel finally broke through on 27 July 2008 after 32 years of technical, financial and contractual problems. The principal technical issues that had to be overcome were the severe squeezing problems in very weak graphitic phyllites at depths of up to 1270 m below surface. Initial attempts to use an open-face TBM in 1976 failed as did attempts to use heavy support to resist squeezing. It was only after the introduction of yielding support in about 1991 that reasonable progress was made. Difficulties continued with floor heave in sections of the tunnel in which horseshoe profiles were used, even after the introduction of yielding support. Finally, in 2004, slow but steady progress was achieved after the Owner and the Contractor agreed that only a circular section, supported by steel sets with sliding joints and a 60 cm shotcrete lining, would be used. Emphasis was placed on developing a routine construction procedure, irrespective of the rock conditions encountered at the face. A detailed discussion on these problems and on methods used to overcome them has been published by Hoek and Guevara (2009).

A total of eight contracts were required to complete the driving of the tunnel. These are briefly described as follows:

First Contract (1976 to 1977). Two 4.8 m diameter open face Robbins hard rock Tunnel Boring Machines (TBMs) were mobilised for excavation from the Intake (Entrada) Portal and the Outlet (Salida) Portal. These machines were selected on the assumption that most of the rock that would be encountered would be of reasonable quality and strength, similar to that seen in the silicified phyllites at the dam site. In 1973 a consultant's report contained the following statement "I imagine that much of the rock along the tunnel alignment will be fairly good phyllite, similar to that seen in the river channel at the dam site. In fact, possibly except for the Bocono Fault and some of the smaller ones, this could probably be essentially an unlined tunnel". An inclined access adit, with a portal located about 7.6 km from the Outlet Portal, was mined by conventional drill and blast methods. The purpose of this adit was to provide early access to the Bocono Fault so that this could be mined manually before the TBM arrived. In later years this included adit was utilised for ventilation.

Second Contract (1977 to 1979). The first and second contracts were operated by the same contractor and resulted in the Intake drive being advanced to a total of 1,700 m and the Outlet drive to a total of 1,850 m. In 1979 it became evident that the occurrence of the graphitic phyllite in the tunnel route was a serious problem. According to Dr Siegmund Babendererde (2002), the site manager for the TBM contract, the machine operated very well but significant convergence and floor heave started 50 to 100 m behind the TBM. The ground support system, designed for better rock conditions than those encountered, could not cope with the squeezing conditions. After the Intake drive TBM had advanced 1,700 m and was operating at a depth of 425 m below surface, the work was suspended during technical and contractual discussions. The TBM in the Outlet drive was removed from the tunnel at this time but the Inlet drive TBM was left in place and it was eventually trapped in the squeezing rock. It was excavated in 1987 during the fourth contract. It is interesting that the inclined adit was advanced a total distance of 1,200 m during the second contract and that, in order to deal with squeezing conditions, yielding support was used (Babendererde, 2002). Unfortunately, this European technique for dealing with squeezing conditions was not used in the main drives until the fifth contract (1991 to 1997).

Third Contract (1981 to 1984) and Fourth Contract (1984 to 1988). The same contractor used drill and blast excavation

in the Outlet drive and the inclined adit. The Intake drive, blocked by the TBM, was not worked on during the third contract and the TBM was removed in 1987 during the fourth contract.

Fifth Contract (1991 to 1997), awarded to a new contractor, utilised conventional drill and blast in the Outlet drive and a roadheader in the Intake drive. This roadheader operated with mixed results and it was eventually abandoned. The contractual period expired and the project was re-bid.

The Sixth Contract (1997 to 2002), Seventh Contract (2002 to 2005) and Eighth Contract (2005 to 2008) were all carried out by the same Venezuelan contractor using conventional drill and blast methods. The final break-through occurred on 27 July 2008.

A ninth contract for the repair and final lining of some sections of the tunnel is currently in progress.

2.2 Lessons learned

Many important lessons related to the theme of this symposium were learned during the Yacambú-Quibor project. Probably the most important of these was that, in spite of complexity of the tectonic environment in which the project is located, shown in Figure 1, there was no reliable Geological model and that no serious effort was made to define the geotechnical characteristics of the rock types encountered along the tunnel. Surface mapping had revealed the presence of two major faults, one of which was encountered in the tunnel. One vertical borehole from surface was attempted at close to the maximum depth of the tunnel but this was abandoned at about 300 m depths due to drilling problems.

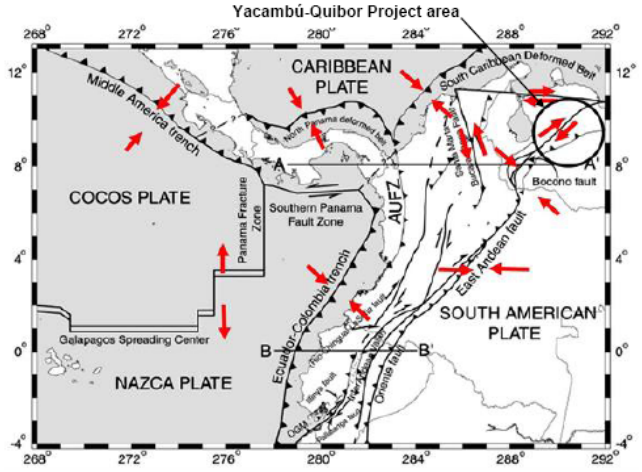


Figure 1 Tectonic plates in the north-western region of South America and Panama. The Yacambú-Quibor project is located in the circled area in the upper right of the figure. After Trekamp et al (2002) with additions by Diederichs (2008).

The graphitic phyllite encountered for significant lengths of the tunnel had been severely sheared by tectonic activity and its strength was very low. The resulting deformation of the tunnel overwhelmed the support, designed for much lower deformations. Even when the presence and behaviour of this graphitic phyllite had become obvious during the first and second contracts, the warning signs had not been heeded and tunnelling continued with horseshoe shaped tunnels using inadequate steel sets and shotcrete linings (Figure 2). The basic principles of tunnel support in squeezing ground were not understood by the designers until the fifth contract, in spite of the fact that these principles had been applied during the driving of the inclined adit in the second contract as described above. The use of a circular tunnel profile with yielding steel sets and a full shotcrete lining (Figure 3) was only fully implemented during the final three contracts (Hoek ad Guevara, 2009).

Figure 2 Re-mining and re-lining of a collapsed section of horseshoe shaped tunnel supported by steel sets and a thin shotcrete shell.

The original five contracts were all traditional fixed price contracts with disputes resolved by Disputed Review Boards or by litigation. The final three contracts were based on an agreed fixed price per metre of tunnel mined. With almost 20 years of tunnelling experience, the actual cost of mining the tunnel was well known and this was used as a basis for contract negotiations.

Figure 3 A circular tunnel over-excavated to 5.2 m diameter and supported by steel sets fitted with two sliding joints which allowed 60 cm of movement resulting in a final diameter of 5.0 m. The sets are embedded in 20 cm of shotcrete except for 1 m wide windows over the sliding joints. These windows were filled 15 m behind the face, when the sliding joints had generally closed, and an additional 40 cm of shotcrete was added. The sheared nature of the graphitic phyllite is evident in the face.

3 THE OLMOS TRANSANDINO TUNNEL IN PERU

3.1 Project background

The Olmos Transandino Tunnel is part of a multi-phase hydroelectric and irrigation project currently being developed by The Regional Government of Lambayeque, Peru. The project consists of a recently constructed dam on the Huancabamba River and a 19.3 km long water diversion tunnel that will convey water from the east side of the Andes to the west, providing irrigation for towns on the Peruvian

Pacific coast. Future phases will include increasing the height of the dam and the construction of a hydroelectric dam downstream of the tunnel outlet.

The original proposal for the project dates back to 1924 but feasibility studies were only conducted in the 1960s. Tunnel excavation commenced in the late 1970s but work was halted in the 1980s due to a lack of funding. Construction of the dam and excavation of the remaining 13.9 km of tunnel was opened to international public bidding in the early 2000s. In July 2004 an agreement was signed with Concesionaria Trasvase Olmos with the contractor Odebrecht Peru, Engineering and Construction, responsible for driving the tunnel by means of a TBM.

This concession is in the form of a 20 year Design, Build, Own, Operate and Transfer contract. This arrangement gives the contractor a very high incentive for constructing the tunnel as quickly and efficiently as possible while, at the same time, ensuring that it can be operated safely and economically for a long period of time.

3.2 Project details

Excavation of the tunnel commenced in March 2007 and it was completed on 20 December, 2011. A 5.3 m Robbins Main Beam TBM was used for the 13.9 km drive under a rock cover reaching approximately 2000 m (Roby et al, 2009).

The main geological units include metamorphic basement rocks (schists) of Paleozoic age, flows of extrusive rock including andesites and dacites of Jurassic, Tertiary and Paleocene age, and intrusive rocks including granodiorite and volcanic flow rocks (tuffs) of Cretaceous and Paleocene age. The original interpretation of the geology specific to the tunnel alignment was based upon detailed mapping of the topography directly above the tunnel and upon two exploratory boreholes. This interpretation, published in 1982, was made by Russian engineers who were responsible for the first contract. The geological cross-section was re-interpreted by Concesionaria Trasvase Olmos who also constructed an as-built geological cross-section. The geologic units encountered are those which were predicted by the Russian geologists although the actual distribution of the rock units varied from those predicted.

Spalling and rockbursting have been an issue throughout the driving of the tunnel with more than 10,000 events being quoted in some publications. Care has to be taken to differentiate between these phenomena. Spalling or popping is a relatively local brittle failure of the excavation boundaries which is sometimes accompanied by snapping or popping sounds with a relatively minor energy release. Rockbursts result in "damage to an excavation that occurs in a sudden or violent manner and is associated with a seismic event" (Kaiser et al., 1995 and Kaiser and Tannant, 1999).

Both spalling and rockbursting are induced by high in situ stresses. The location of spalling in the roof, as was common in Olmos, indicates that the horizontal stresses are higher than the vertical stresses. Bursting of the face, which was one of the more serious types of failure in Olmos, occurs when the horizontal stress parallel to the tunnel axis is higher than the vertical stress. Reliable measurement of all the in situ stresses at depths in excess of 1000 m is not practical and hence it is not possible to predict the location and magnitude of rockburst events. However, in the case of Olmos, it was found that transitions from rhyolite, latite and granodiorite into dacite were marked by severe bursting. The dacites contain persistent sub-vertical structures that interact with the accumulation of stress-induced fractures to guide the fracturing process outwards creating large volumes of damaged rock that can then fail instantaneously along the structures creating rockbursts with extensive overbreak.

Until December 2008 the tunnel suffered from ongoing spalling and popping but this was not a serious impediment to progress and an advance rate of 12.6 m per day was maintained with over 8.4 km of tunnel being completed in 22 months. On 22 December 2008 the tunnel encountered serious rockbursting in dacites and the advance rate dropped to 2.7 m per day. Several serious rockbursts occurred and the largest of these, on 29 April 2010, resulted in significant damage to the TBM which was not able to restart operations until 8 August, 2010.

In May 2011 a transition from dacite into basement schist occurred and the rockburst problem was reduced. Advance rates picked up again and a completion date for the tunnel was projected for November 2011. However, Consortium Trasvase Olmos suspended work in June, claiming it had suffered a loss of revenue of US $70 million as a result of delays arising from the rockburst problems about which they had not been adequately informed. Work resumed in October and the tunnel broke through on 20 December 2011 (Vigo, M. 2011).

3.3 Lessons learned

The high stress problems in the strong brittle rock mass through which the Olmos tunnel was driven were responsible for spalling and rockbursts which resulted in significant delays in completion of the tunnel. Reasonable geological predictions were available and the maximum cover of 2000 m suggested that stress induced failure could be a problem in driving this tunnel. However, the magnitude of the rockbursts and the overbreak that occurred could not be predicted and this presented a major challenge in excavating this tunnel and will continue to present similar challenges in driving future tunnels in hard rock at these depths.

The World Stress Map (Heidbach, 2008) of the project area, reproduced in Figure 4, shows that the major horizontal stress is generally parallel to the trans Andean Olmos tunnel axis and this is confirmed by the experience of rockbursting ahead of the TBM face. However, the World Stress Map gives only stress directions and the magnitudes are very difficult to establish at these depths.

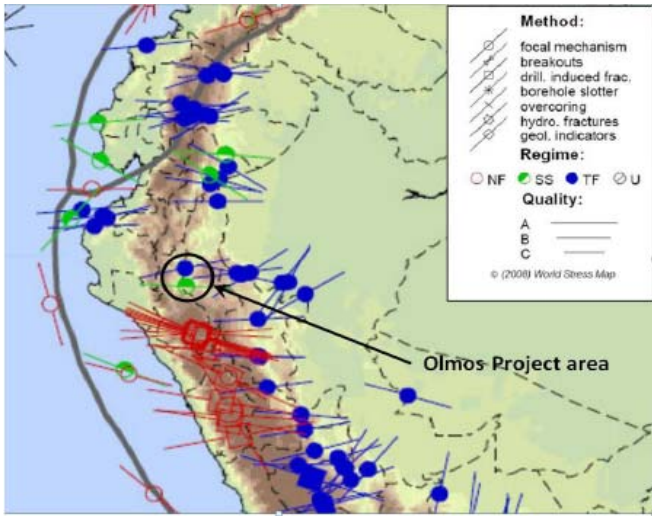


Figure 4 World Stress Map detail of the Olmos project area in Peru.

Direct in situ stress measurements from surface are typically limited to a depth of less than 100 m. Measurements have been carried out successfully to depths of 500 m but, due to the complexity of manipulating equipment at that depth, the success rate is very low. Hydraulic fracture techniques for stress measurement only give reliable measure-

ments of the minimum principal stress and, where this is vertical as in the case of the Olmos tunnel, these techniques do not help. Consequently, at this time, horizontal in situ stresses in the rock surrounding very deep tunnels cannot be measured directly during site investigations and this makes it very difficult to predict spalling and rockbursting accurately and to plan for dealing with these problems when encountered.

In planning the excavation and support of the 13.9 km of TBM driven tunnel the contractor chose a robust and powerful open face hard rock TBM. The machine was fitted with a short shield in order to minimise the danger of the machine being trapped by surrounding debris in the event of a rockfall, spall or burst. The support system, illustrated in Figure 5, consists of a precast concrete invert, with a drainage channel and rail mounts included, and continuous steel sets spaced at 1 m placed in spaces in this invert.

Figure 5 Precast concrete invert sections and steel sets used to support the Olmos tunnel.

The advantage of this support system is that the tunnel invert water is controlled and the inset rail mounts allow accurate alignment of the rails which, in turn, translates into reliable high speed train movements which are critical in maintaining delivery of materials and equipment and in removal of muck from the tunnel. These are important practical considerations since time lost in drainage and in derailments or slow travel can have a major cumulative impact on the construction schedule.

The steel sets, while not sufficiently robust to withstand major loads from a rockburst or rockfall, provide a safe canopy under which the miners can operate. Wire mesh or rebar mats placed over the top half of the sets prevent small pieces of rock falling on the miners. In the event of a damaging burst or fall the sets can be severely deformed but they still provide some protection and are relatively simple to replace once the area has been stabilised. The one benefit of rockbursts is that once the energy has been released the rock tends to stabilise and further events in the same location are unlikely. Hence, by allowing the ground to settle for approximately 30 minutes after a burst, the area can be re-entered safely. The steel sets are fully embedded in high quality robot applied shotcrete immediately behind the trailing gear of the TBM and this results in a completed tunnel as shown in Figure 6.

This system of precast concrete inverts, regular steel set installation and shotcrete application as an off-line activity behind the TBM trailing gear is a highly efficient process in which each miner knows exactly what to do and the overall schedule can be tightly controlled as in a factory production line operation. Of course, when a serious rockburst or rockfall occurs, the advance of the face stops but the facilities to drain the tunnel and to move the equipment required for repair to the face remain fully operational, allowing the time required for the repair to be minimised.

Figure 6 Fully shotcreted tunnel behind the TBM trailing gear.

The design-build-own-operate type of contract used in the construction of the Olmos tunnel creates a very high incentive for the contractor to work quickly and efficiently and to produce a high quality end product which will operate safely and efficiently during the concession period and beyond. As was the case in Olmos, this type of contract does not guarantee that there will be no disputes or claims but these are generally limited to very specific issues which may be simpler to resolve than in conventional fixed price contracts.

Finally, it is worth exploring whether the Geological Data Report and the Geotechnical Baseline Report concept, which has been widely adopted in North America and is gaining acceptance in other countries, would have helped in the case of the Olmos tunnel? The Geological Data Report, which is a compilation of all of the results of the site investigation process, has been in use for many years. However, this report is generally restricted to factual information and it does not include very much interpretation. The contractor is left to assess the factual information and draw conclusions on the probable groundwater and rock mass behaviour; tasks that may be very difficult to accommodate during the bidding process.

The Geotechnical Baseline Report (URTC, 1997, 2007) takes this process one step further. It is an interpretative report in which all the factual data collected during the site investigation stages are analysed in terms of potential groundwater and rock mass behaviour and other issues that could cause problems during construction. These interpretations and recommended solutions are presented in the report and form a behavioural baseline which can be used in setting contractual limits. The contractor cannot make claims for ground behaviour which falls at or above the baseline while the owner has to accept responsibility for problems resulting from rock mass behaviour which is worse than that predicted in the baseline report.

Even if all the questions cannot be fully resolved, the preparation of the Geotechnical Baseline Report forces the geologists, geotechnical engineers and design engineers to consider the questions that they are required to address very carefully. Has a reliable geological model been prepared? Has the pre-construction groundwater distribution been studied and the rock mass permeability investigated so that predictions of groundwater movement during construction can be made? Have sufficient high quality diamond drill cores been recovered, logged and tested in the laboratory? Have the in situ stresses been measured or, if not, has an attempt been made to assess these stresses from measured stresses on nearby projects or from geological reasoning?

In the case of the Olmos project and similar deep tunnels, the problem of determining the in situ stresses is a difficult one to resolve. There are several examples of tunnels where high (and sometimes low) in situ stresses have caused significant construction problems. In most cases, the in situ stresses had not been accurately predicted nor the danger of spalling or rockbursts fully assessed before the start of construction. As discussed earlier, reliable direct measurement of in situ stresses is a complex problem in high cover situations with no intermediate access to the deepest sections of the tunnel alignment. It is anticipated that this will remain a technical problem for years to come. It is hoped that the presentation of case histories such as that of the Olmos tunnel will alert owners, contract managers and insurance companies to these problems but also show that they can be overcome by logical contractual procedures.

4 REDUCING GEOLOGICAL RISK IN TBM TUNNELLING

4.1 Background

The geological conditions and the stability of the rock mass in which a tunnel or cavern is to be excavated are probably the greatest sources of risk in a project involving underground construction. In the absence of a reliable geological model the project can go seriously wrong. Even when a good geological model is available, the interpretations of the rock mass characteristics and of the behaviour of the excavations are not trivial tasks and construction problems cannot be avoided completely, irrespective of the type of contract adopted.

Given this situation it is appropriate to ask whether there is anything else that can be done to alleviate the risk, particularly for long, deep tunnels which will become more common as the demands for more transportation routes, water diversion projects, hydropower developments continue to grow. Fortunately, there is a viable option that involves making the tunnelling less sensitive to geological and geotechnical uncertainty by adopting a tunnel lining strategy that is as independent as possible from the geological conditions.

One example of this approach has already been discussed in the case history of the Olmos tunnel in Peru. While it had been anticipated that there would be problems due to overstressing of the rock mass surrounding the tunnel, the magnitude and frequency of the spalling and rockbursts could not be estimated with any degree of reliability. It was therefore decided to utilise a support system that could be installed routinely throughout the tunnel, irrespective of the conditions encountered. This support system, using precast concrete invert segments, steel sets and full embedment in shotcrete, was designed to cope with typical overstressing problems and it was set up to maximise production in the tunnel. Unusually heavy rockbursts overwhelmed this support system from time to time but the resulting problems proved possible to repair and the tunnel was completed successfully, albeit with significant delays.

There are several other examples where this approach has been applied deliberately and where very good results were obtained in a wide variety of geological conditions. One of these projects is discussed in the following section.

4.2 Yellow River Diversion Project in Shanxi Province, China

The Yellow River diversion project includes more than 300 km of tunnels and conduits, treatment plants and pumping stations. It is designed to divert water from the Yellow River to meet the critical water supply needs of the Shanxi provincial capital of Tai Yuan and, in the future, the city of Da Tong. The project component dealt with here covers four 4.9 m diameter TBM driven tunnels with a total length of 88.7 km (Wallis, 2009, Kolić et al, 2009, Lampiano et al, 2001).

The project is located in the Gobi desert in the dry northwest corner of China. A summary of the topography and predominant rock types as well as the performance of the 4 TBMs is presented in Figure 7. It can be seen that the main rock types encountered by Tunnels 4, 5 and 6 are limestones and dolomites with frequent karst features and bands of soft plastic clay. Tunnel 7 encountered coal measure rocks with gas as well as Triassic sandstone and mudstone. Water inflow was limited in Tunnels 4, 5 and 6 but was abundant in Tunnel 7.

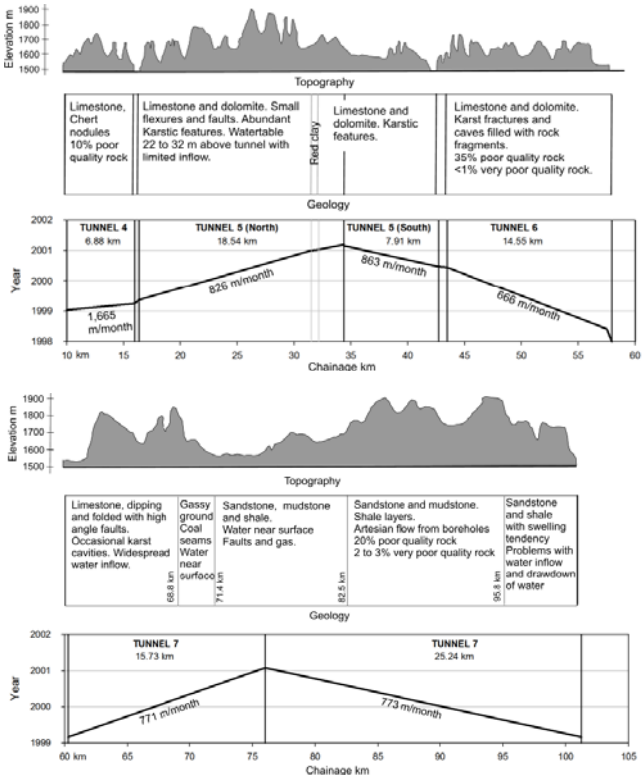


Figure 7 Topography, geology and tunnel performance for Tunnels 4, 5, 6 and 7 of the Yellow River Diversion Project in China. (After Babendererde, 2007)

Starting in 1989/1999, four double shield TBMs were deployed to excavate these tunnels. Two new Robbins machines, one refurbished Robbins machine and one new NFM-Boretec machine were used. All the TBMs were fitted with back-loading 17 inch (432 mm) disk cutters and the new machines were all equipped with variable speed electric motors. The used Robbins TBM was fitted with two-speed electric motors with gear reducers and hydraulic clutches. All the machines were operated on three 8 hour shifts per 24 hours for 6 days per week.

The outstanding performance of these four TBMs is due largely to the use of precast concrete Honeycomb segments, illustrated in Figures 8 and 9. These segments are installed within the tail shield of the TBM with two opposing segments being installed while thrust to move the machine forward is reacted by the other two segments. Pea gravel is pumped into the gap between the tunnel walls and the tail shield, immediately behind the machine. About 60 m behind the machine this pea gravel is grouted to complete the lining installation.

Having the rails fixed accurately to the precast invert allowed train speeds of 20 km/hour to be maintained to ensure timely delivery of segments and supplies to the face and the efficient removal of muck from the tunnel. These are critical factors in maintaining a tightly controlled schedule in this type of tunnelling operation.

Figure 8 Assembly of Honeycomb pre-cast concrete segmental lining showing the interlocking of the segments. The rail mounts and drainage channel are cast into the invert segment. Photograph provided by Dr Siegmund Babendererde.

Figure 9 Segments with rubber sealing gaskets to allow grouting of the space between the bored tunnel walls and the lining and also to prevent loss of water from the operating tunnel.

4.3 Lessons learned

The example of the Yellow River diversion project in China and a very similar outcome in driving a 12.2 km long 4.88 m diameter tunnel for the Guadiaro-Majaceite water project in Spain (Castello et al, 1999) demonstrates the utilisation of double shield TBMs with simultaneous installation of pre-cast concrete liners within the tail shield of the machines. The ability to maintain a continuous supply of concrete segments and equipment and to remove the muck from the tunnel by means of trains running on accurately aligned rail set on the invert segment was a critical factor in achieving the very high excavation rates.

More importantly, the utilization of this system meant that the tunnel drives were effectively independent of the geological conditions through which the tunnels were excavated. There was no need for endless discussions at the tunnel face about the class of the ground, the type of support to be installed, whether rockbolts should be used and how long they should be. The segments were designed to deal with all of the support issues and to provide a watertight one pass lining.

Of course there were problems and delays in all of these tunnels. Cutting heads were replaced, gearboxes repaired, TBMs trapped in squeezing ground had to be freed and some soft ground sections had to be excavated by hand. However, the delays caused by these problems were of minor significance in terms of the overall project schedule.

It is not suggested that this approach is universally applicable to tunnelling. However, these examples do demonstrate that "thinking outside the box" can sometimes reduce the number of impediments encountered in tunnel driving and, in particular, isolate the tunnel driving process from some of the geological and geotechnical uncertainties or changed ground conditions that can cause so many problems.

5 NATHPA-JHAKRI HYDROELECTRIC PROJECT IN INDIA

5.1 Project background

The Nathpa-Jhakri hydroelectric project is located in the Himalayan foothills in the state of Himachal Pradesh in India and it consists of the following components:

- 40 m high concrete gravity dam across the Satluj river
- 4 x 525 m long x 27.5 m high x 16.3 m wide desilting chambers,
- 27.4 km long 10 m diameter headrace tunnel,
- 301 m deep 21.6 m diameter surge shaft,
- 222 m long, 20 m span x 49 m high underground powerhouse,
- 196 m long x 18 m span x 27.5 m high underground transformer hall and
- 983 m long 10 m diameter tailrace tunnel.

Construction commenced in 1993 with commissioning in May 2004. The project operates at a head of 428 m and produces 1500 MW of power. A comprehensive description of the project by the Geological Survey of India entitled "Nathpa-Jhakri hydroelectric project, Himachal Pradesh, India" can be found at http://en.wikipedia.org/wiki/Nathpa_Jhakri_Dam.

The Geological Survey of India was responsible for the geological site investigations which included 24 boreholes (2575 m of core) and 7 exploratory adits. Excellent geological maps were produced and the conditions encountered during construction were generally in accordance with these maps.

A traditional fixed-price contract was used in accordance with the owner's normal procedure. International bids were invited and three separate contracts were awarded for the dam and upstream works, the headrace tunnel and the surge shaft and the underground caverns and tailrace tunnel.

A complete discussion on this project exceeds the scope of this paper and the following presentation is limited to the excavation of the headrace tunnel through the Daj Khad fault zone.

5.2 Daj Khad fault zone

The 400 m wide Daj Khad fault zone had been accurately predicted in the geological model but the characteristics of the rock mass were not well defined and it was anticipated that conventional steel set support would be sufficient for

the excavation of this zone. Figure 10 shows significant deformation in the saturated and heavily sheared gouge encountered in the top heading of the tunnel. The contractor was unable to stabilize the fault zone using steel set support and other methods available to him.

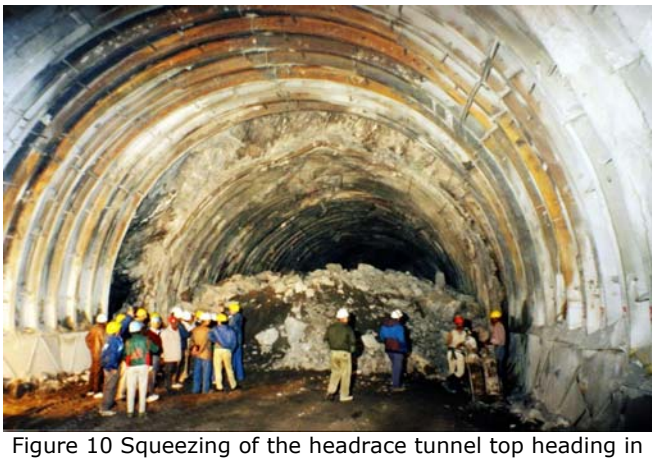


Figure 10 Squeezing of the headrace tunnel top heading in the Daj Khad fault zone.

After lengthy discussions between the designers, the contractor and the project owner's Panel of Experts, it was decided to bring in the Italian consulting company Geodata to assist. They recommended stabilization of the tunnel face by means of drainage and the use of 12 m long grouted pipe forepoles as illustrated in Figures 11 and 12. This method has been used successfully in the past (Carrieri et al, 1991) and, although very expensive, it was considered to be the most appropriate approach for this situation. The zone was excavated successfully with the contractor being paid on a time and materials basis for his work.

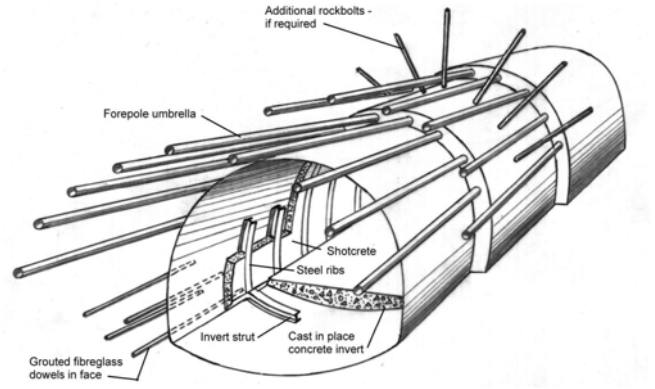


Figure 11 Advancing a tunnel under a forepole umbrella. Note that not all of these components were used in the Nathpa Jhakri project.

Figure 12 Excavating through the Daj Khad fault zone using forepoles.

5.3 Lessons learned

The Nathpa-Jhakri hydroelectric project is a very large and complex project which was successfully completed using site investigation, design and construction methods which are typical of those used by large state-owned hydroelectric power corporations. An issue that required outside help was the stabilisation of the headrace tunnel through the Daj Khad fault as described above. This was handled as a special item in the contract and paid for on a time and materials basis.

Within the three contracts for the complete project there were problems and delays of the type that can be anticipated in large complex underground projects of this kind. These were resolved with the aid of a Disputes Review Board that met regularly. Where an unanticipated problem is encountered and this problem has a relatively minor impact on the cost and schedule of the entire project, as in the case of the excavation of the Daj Khad fault, dealing with this problem by means of a change order or a small sub-contract is probably the simplest and most efficient solution. When the unanticipated problems cannot be resolved with the tools available, as for the Yacambú-Quibor case discussed earlier, it may be more effective to terminate the contract as soon as possible and to reassess the entire project before proceeding. Of course, changing contracts mid-way is never a simple process and all the implications of this course of action have to be considered very carefully before taking this route.

In many countries the state-owned organisations, of the type responsible for the Nathpa-Jhakri project, have been largely disbanded. Some of these organisations have been privatised while others have been broken up and the components privatised. It is not unusual to find a small group of administrative staff managing a variety of consultants and contractors who are responsible for most of the tasks originally performed by the organisations themselves. While there is nothing fundamentally wrong with this new model, the lack of a of a pool of experienced people, who have worked together for many years, can give rise to technical and contractual problems that will be more difficult to resolve and which may require different types of contractual arrangements.

6 MINGTAN PUMPED STORAGE PROJECT IN TAIWAN

6.1 Project background

The Mingtan Pumped Storage Project in Taiwan has an installed capacity of 1600 MW with six reversible pump-turbines housed in an underground cavern 300 m below the ground surface. The upper reservoir is the existing Sun Moon Lake which provides a maximum static head of 403 m.

The underground powerhouse complex consists of two caverns. The main powerhouse cavern is horseshoe shaped with a span of 22 m and a height of 46 m. The transformer cavern is located 45 m downstream of the powerhouse cavern and is also horseshoe shaped with a span of 12 m and a height of 17 m. These caverns are located in a predominantly sandstone formation, dipping at 35 degrees, with relatively weak siltstone layers up to 2 m thick. Most of the bedding planes and contacts between rock types are sheared as a result of previous tectonic movements. (Cheng and Lui, 1990, Liu and Hsieh, 1991). A detailed description of the geotechnical aspects of the project will be found in Hoek (2007).

6.2 Improving the rock mass above the underground caverns

While the overall contract for the project was a typical unit price contract, an unusual feature was that there was a relative large preliminary contract during which extensive

site investigation and construction were carried out. This included site investigation and in situ tests in existing exploration/drainage adits, 10 m above the powerhouse and transformer caverns, as well as the construction of many of the access roads, the laydown areas and the contractor's camp site. This preliminary contract also provided the opportunity for significant rock improvement works to be carried out in the rock above the powerhouse and transformer caverns, so that main contractor could work efficiently in "good rock" conditions.

Detailed mapping during site investigation had defined a significant number of dipping fault structures crossing both the powerhouse and the transformer caverns. An isometric view of a typical fault plane is reproduced in Figure 13. The influence of these faults on the stability of the cavern was of major concern. It was decided that pre-treatment of the cavern roof was necessary in order to ensure that the main contract could proceed without severe problems due to roof instability. This pre-treatment consisted of removal and replacement of the clay seams in the faults to the maximum extent possible, followed by reinforcement of the rock mass in the roof by means of grouted cables.

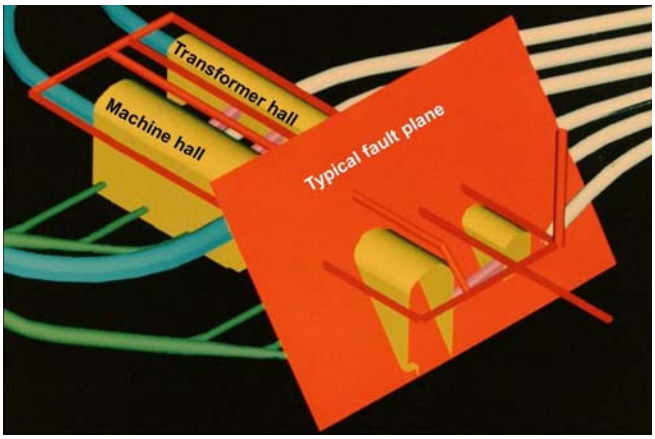


Figure 13 Isometric view of underground power and transformer caverns showing a typical fault plane crossing the caverns.

The treatment of the faults involved high pressure washing of the clay seams and backfilling the voids with non-shrinking concrete. This technique was developed for the treatment of similar faults in the foundation of the Feitsui arch dam near Taipei (Cheng, 1987). Figure 14 shows the arrangement of longitudinal working galleries and cross-cuts used to access the clay seams. It was found that the clay washing and replacement could be carried out to a depth of about 4 m. The thickest and weakest fault was excavated manually and backfilled to a similar depth.

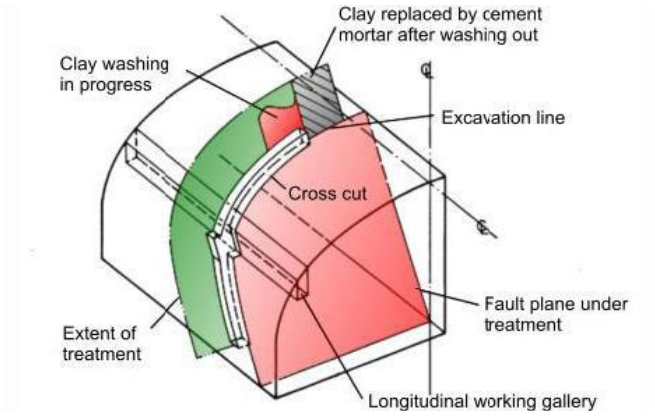


Figure 14 Washing and replacement of clay seams in the faults encountered in the roof and upper sidewalls of the Mingtan power cavern.

Once the clay seam treatment process had been completed the rock mass above the caverns was reinforced by means of 50 tonne capacity cables as shown in Figure 15. These cables were installed downwards from the central exploration/drainage adits and upwards from the two longitudinal working galleries. Since these cables were installed before any excavation had taken place in the caverns they were untensioned except for a few tons of straightening load. Deformation of the rock mass during excavation of the caverns resulted in tensioning of the cables. The fully excavated powerhouse cavern roof is illustrated in Figure 16. The sequence of excavation and reinforcement of the powerhouse cavern is illustrated in Figure 17.

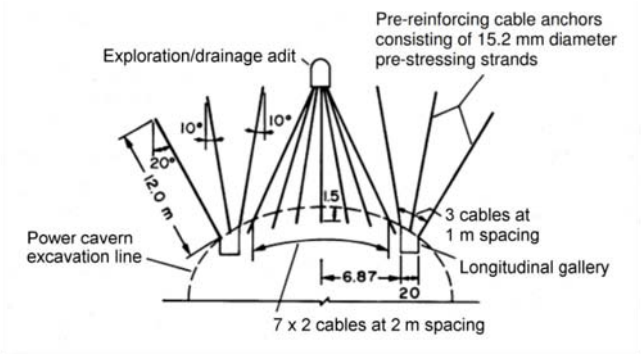
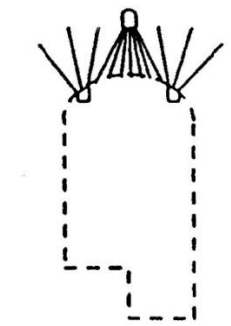


Figure 15 Pre-reinforcement of the power cavern roof by means of grouted untensioned cables placed from the longitudinal working galleries and from an existing exploration and drainage gallery 10 m above the cavern roof.

Figure 16 Excavated Mingtan powerhouse arch showing some of the reinforcing cables before they were trimmed and shotcrete applied.

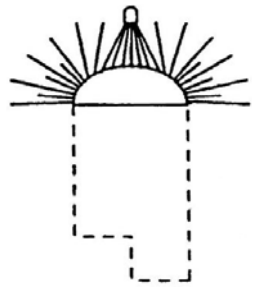
Note that a 22 m span powerhouse cavern cannot be supported by means of steel sets or thin shotcrete linings since these do not have sufficient capacity to resist rock movements. In the past the arches of many underground powerhouses have been supported by reinforced concrete arches but, in deformable sedimentary rock such as that in which the Mingtan cavern was excavated, these arches are too stiff and can fail as a result of the lateral pinching action which occurs as the cavern walls converge during excavation of the lower benches. Reinforcement by means of cables improves the overall strength of the rock mass and results in a much more flexible system which can accommodate the progressive convergence of large caverns during excavation.

Cables, such as those used in the rock mass above the Mingtan cavern arches, can only be left untensioned if they are installed before excavation of the cavern. Once excavation of the cavern commences, the cables in the lower portion of the arch and in the sidewalls must be tensioned to a load calculated on the basis of the amount of deformation to which each cable will be subjected

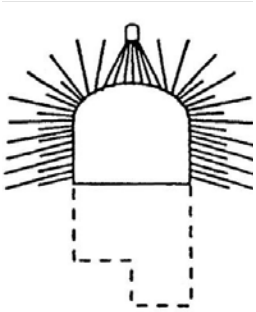


Installation of double corrosion protected cables from exploration/drainage gallery located 10 m above centre of roof arch and from two longitudinal working galleries. The 50 tonne capacity cables were installed on a 2 m x 2 m grid pattern and a small straightening load of 5 tonnes was applied before grouting.

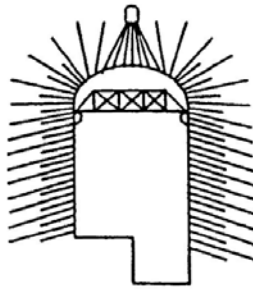
Dashed line shows cavern profile before excavation



Excavation of cavern roof from a centre heading with slashing of the sides and the application of the first 50 mm of steel fibre reinforced micro-silica shotcrete. End fixings and faceplates were added to projecting ends of the cables which were tensioned to 20% of ultimate capacity to ensure positive anchorage. Where required, 5 m long 25 mm mechanically anchored, tensioned and grouted rockbolts were installed at the centres of the 2 m x 2 m grid of reinforcing cables.



Excavation of the cavern by 2.5 m vertical benches. Double corrosion protected 112 tonne capacity cables, inclined downwards at 15° to cross dipping bedding planes, were installed on a 3 m x 3 m grid in the sidewalls. Before grouting these were tensioned to 38 to 45% of yield strength, depending upon their location relative to the bench. Intermediate 6 m long 25 mm diameter tensioned and grouted rockbolts were installed at the centres of the pattern of reinforcing cables. Final shotcreting of the roof was carried out at an early stage of benching.



Complete excavation of the cavern with 150 mm total thickness of steel fibre reinforced micro-silica shotcrete on the roof and upper sidewalls and 50 mm thickness on the lower sidewalls. Access to the roof for inspection and minor remedial work was provided by a temporary construction crane.

Figure 17 Sequence of excavation and reinforcement of the powerhouse cavern.

The shotcrete used as a final internal lining is designed to support the rock pieces that can become detached between the cable faceplates, typically installed on a 2 m x 2 m grid pattern. Wire mesh or steel fibre reinforcement is generally used to improve the tensile capacity of these shotcrete layers. The support provided by the thin layer of shotcrete, typically about 150 mm thick, is ignored in calculating the required capacity of the reinforcing cables.

6.3 Lessons learned

The identification and treatment of the vulnerable rock masses above the powerhouse and transformer caverns during a preliminary contract meant that a conventional fixed price contract could be applied with confidence to the main contract and that it worked successfully. This option is not always available in underground construction, particularly in long, deep tunnels where it is difficult to gather sufficient information before construction and where the opportunity to implement such measures during construction is very rare. However, in the construction of underground caverns it is worth examining this type of option since the simplification of the main contract has significant cost and schedule advantages.

In accordance with underground cavern design procedures, no allowance was made for earthquake loading in the design of the Mingtan underground complex. Hence the loading imposed by the 7.6 magnitude Chi-Chi earthquake of 21 September 1999, with its epicentre at a depth of 7 km about 15 km from the Mingtan site, represented a good test of the validity of this design approach.

Charlwood el al (2000) report that thousands of buildings were damaged, 2,200 people were killed and more than 8,000 were injured in the area surrounding the epicentre. The concrete gravity dam on the Mingtan project was undamaged but, at a penstock river crossing, some components of expansion couplings in the penstocks were deformed due to longitudinal movements. These couplings did not fail, the deformed components were replaced and the penstocks quickly returned to service. The project was in operation at the time of the earthquake and the underground excavations were undamaged, although there was a loss of power and lighting underground. Several people were working in the plant at the time and apparently felt only minor shaking. These observations confirm that deep underground excavations are much less vulnerable to seismic ground motions than those at surface.

7 CONCLUSIONS

The examples presented demonstrate that the increasing demand for long, deep tunnels creates new problems for the construction industry. Because of limited access, it is difficult to apply traditional site investigation techniques so that, in many cases, the amount of information available is very limited and the preparation of detailed designs for differing ground conditions occurring along the tunnels are not practical. This means that engineers and contractors have had to develop approaches that permit the tunnels to be constructed in such a way that geological and geotechnical variations do not play a dominant role in the process.

The Yellow River Diversion tunnels in China and the Guadiaro-Majaceite tunnels in Spain are excellent examples of the use of a tunnelling method, based on double-shield TBMs with simultaneous installation of precast concrete linings. This makes the process largely independent of the geological conditions. To a lesser extent, the Olmos Transandino tunnel in Peru and the last stages of the Yacambú-Quibor tunnel in Venezuela are also examples where single support systems were installed routinely in order to permit the tunnels to be advanced without the need for frequent changes in methodology to deal with differing ground conditions.

One of the most serious impediments to rapid and efficient tunnel construction is the endless tinkering with tunnel support in an attempt to optimize these designs to the ground conditions encountered. This is also one of the main sources of claims and disputes since it is very seldom that

the various parties involved will agree on the definition of the geological and geotechnical conditions and the methods that should be used to stabilize the tunnel. In the cases mentioned above, support systems designed to deal with most of the conditions encountered were installed routinely and the field engineers and geologists were not permitted to interfere with this process. Their advice was only sought when exceptional conditions occurred.

I am entirely in agreement with this process and I foresee that, as TBMs continue to develop, the tendency to use lining systems installed simultaneously with the advance of the machine will become more and more common.

In direct contrast to these trends is the increasing sophistication of site investigation and design methods for large underground caverns. These caverns are concentrated in a limited volume of rock and it is justified to devote signifycant resources to the detailed definition of this rock volume. Exploration adits and test galleries are general constructed to allow detailed geological mapping, in situ stress measurement and deformation modulus testing. Comprehensive geological and geotechnical models are compiled, usually well in advance of the start of construction. This means that excavation sequences and support methods can be prepared and, in some cases such as the Mingtan project in Taiwan, work can be done during preliminary contracts to make the tasks of the main contractor simpler and safer.

Again, I am in complete agreement with this approach and I see no contradiction between this approach and the hands-off approach for driving tunnels where it is difficult or impractical to collect sufficient reliable information.

It would be nice to end this paper with a neat list of recommendations for different types of contract that have been found to work well for differing ground conditions. Unfortunately, having worked on a large number of projects in every conceivable set of ground conditions, I am forced to conclude that the compilation of such a list is not possible. The form of contract adopted on a particular project depends, to a very large extent, on the limitations imposed on the project management by the ultimate owner and by the organisations providing funding for the project. Even when these constraints and limitations do not exist, it is very difficult to decide what type of contract is best suited to a project. In fact, my experience suggests that the success of an underground project has less to do with the type of contract used than it does with both the owner and the contractor having experienced and competent project managers, geologists and engineers who are prepared to discuss technical issues in a logical and non-confrontational way.

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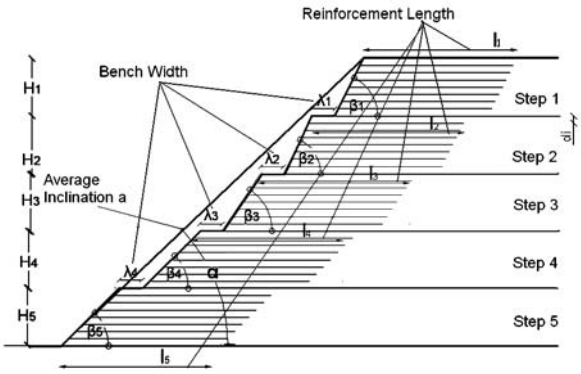
ΠΕΡΙΛΗΨΕΙΣ ΠΡΟΣΦΑΤΩΣ ΥΠΟΣΤΗΡΙΧΘΕΙΣΩΝ ΔΙΔΑΚΤΟΡΙΚΩΝ ΔΙΑΤΡΙΒΩΝ

Αναλυτική, Πειραματική και Υπολογιστική Διερεύνηση Οπλισμένων Πρανών έναντι Στατικής και Σεισμικής Φόρτισης

Έλενα Καπόγιαννη

Στα πλαίσια της Διδακτορικής Διατριβής μελετήθηκε η συμπεριφορά οπλισμένων πρανών με απλή και σύνθετη γεωμετρία, έναντι στατικής και σεισμικής φόρτισης. Ειδικότερα, πραγματοποιήθηκε αναλυτική, πειραματική και υπολογιστική διερεύνηση οπλισμένων πρανών, καθώς και σύγκριση των αποτελεσμάτων των μεθόδων, με στόχο να προκύψει μια ολοκληρωμένη εικόνα τόσο για τις υπό μελέτη κατασκευές, όσο και για τις ίδιες τις μεθόδους που εφαρμόσθηκαν.

Κατά την **αναλυτική διερεύνηση** αναπτύχθηκε νέα αναλυτική λύση, η οποία και ενσωματώθηκε σε ολοκληρωμένη μεθοδολογία, που δημιουργήθηκε για τον σχεδιασμό και την μελέτη ενιαίων οπλισμένων πρανών καθώς και πρανών με αναβαθμούς, έναντι στατικών και σεισμικών φορτίσεων. Βάσει της αναλυτικής λύσης και της μεθοδολογίας που αναπτύχθηκε, δημιουργήθηκε λογισμικό, 5000 γραμμών, σε γλώσσα προγραμματισμού Embarcadero Delphi, με στόχο την ολοκληρωμένη μελέτη των πρανών έναντι στατικών και σεισμικών δράσεων. Τα αποτελέσματα της αναλυτικής λύσης καθώς και της μεθοδολογίας που αναπτύχθηκε, συγκρίθηκαν με αντίστοιχα αποτελέσματα υπολογιστικών μοντέλων που δημιουργήθηκαν με γεωτεχνικά προγράμματα του εμπορίου.



Σχήμα 1. Οπλισμένο πρανές Με αναβαθμούς (Kapogianni & Sakellariou, 2008).

Σύμφωνα με την νέα αναλυτική λύση που προτάθηκε, εφαρμόζεται ο «Μηχανισμός Επίπεδης Αστοχίας» (Plane Failure Mechanism) δύο φορές. Αρχικά, προκειμένου να εξασφαλιστεί ότι η εφελκυστική αντοχή και το μήκος του οπλισμού επαρκούν έναντι τοπικής ευστάθειας για τον κάθε ένα αναβαθμό ξεχωριστά και στην συνέχεια έναντι ολικής ευστάθειας για ολόκληρο το πρανές. Είναι απαραίτητο να εφαρμοστούν και οι δύο μορφές του μηχανισμού, καθώς ο έλεγχος έναντι τοπικής ευστάθειας δίνει κρισιμότερα αποτελέσματα για τους ανώτερους αναβαθμούς, ενώ ο έλεγχος έναντι ολικής ευστάθειας είναι κρισιμότερος για τους κατώτερους αναβαθμούς.

➢ *Έλεγχος έναντι Τοπικής Ευστάθειας (Local Stability)*

Κατά τον έλεγχο έναντι τοπικής ευστάθειας, υπολογίζεται ξεχωριστά για κάθε αναβαθμό i, η συνολική ποσότητα του οπλισμού σε κανονικοποιημένη μορφή: K, σύμφωνα με την παρακάτω Εξίσωση:

$$K_i = \frac{2G_i \tan(\Omega_i - \varphi_i) + 2k_{hi}G_i}{\gamma_i H_i^2}$$

Η παραπάνω εξίσωση λαμβάνει μέγιστη τιμή για Ki/∂ (Ω)=0,

όπου G_i υπολογίζεται από την παρακάτω εξίσωση:

$$G_i = G_{i1} + G_{i2} + \ldots G_{ij} + \ldots + G_{ii}$$

όπου j ο αριθμός των ανώτερων αναβαθμών που επηρεάζουν τον συγκεκριμένο τοπικό μηχανισμό ευστάθειας. Επιπλέον θα πρέπει να λαμβάνεται j<i,

όπου G_{ii} είναι το βάρος του αναβαθμού που εξετάζεται για τοπική ευστάθεια:

$$G_{ii} = \frac{0.5\gamma_i H_i^2 \sin(\beta_i - \Omega_i)}{\sin\Omega_i \sin\beta_i}$$

και G_{ij} το εδαφικό βάρος των ανώτερων αναβαθμών:

$$G_{ij} = (2(l_i - \lambda_{i-1} - \lambda_{i-2} - \ldots - \lambda_j - \frac{H_{i-1}}{\tan\beta_{i-1}} - \frac{H_{i-2}}{\tan\beta_{i-2}} - \ldots - \ldots - \frac{H_{j+1}}{\tan\beta_{j+1}}) - \frac{H_j}{\tan\beta_j})\frac{H_j}{\tan\beta_j}\gamma_j$$

στην περίπτωση που $i-1 > j+1$, ενώ για $i-1 < j+1$:

$$G_{ij} = (2(l_i - \lambda_j - \frac{H_j}{\tan\beta_j}) - \frac{H_j}{\tan\beta_j})\frac{H_j}{\tan\beta_j}\gamma_j$$

➢ *Έλεγχος έναντι Ολικής Ευστάθειας (Global Stability):*

Προκειμένου να προσδιορισθεί ο κρίσιμος μηχανισμός αστοχίας χρησιμοποιείται η παρακάτω εξίσωση:

$$K_{gl} = \frac{2(G_1+G_2+\ldots+G_n)\tan(\Omega_{gl}-\varphi_{gl})+2k_h(G_1+G_2+\ldots+G_n)}{\gamma(H_1+H_2+\ldots+H_n)^2}$$

η οποία λαμβάνει μέγιστη τιμή για $\partial K_{gl}/d(\Omega)=0$,

όπου φ_{gl} η μέση γωνία τριβής του πρανούς, k_{gl} η μέση αναμενόμενη εδαφική επιτάχυνση, n ο αριθμός των αναβαθμών του πρανούς και $G_2,\ldots G_n$ το βάρος των αναβαθμών με τις παρακάτω εκφράσεις:

$$G_1 = \left[\frac{H_1+2H_2+2H_3+\ldots+2H_n}{\tan\Omega_{gl}} - \frac{H_1}{\tan\beta_1} - \frac{2H_2}{\tan\beta_2} - \frac{2H_3}{\tan\beta_3} - \frac{2H_n}{\tan\beta_n} - 2\lambda_1 - 2\lambda_2 - \ldots - 2\lambda_{n-1}\right]\gamma_1\frac{H_1}{2}$$

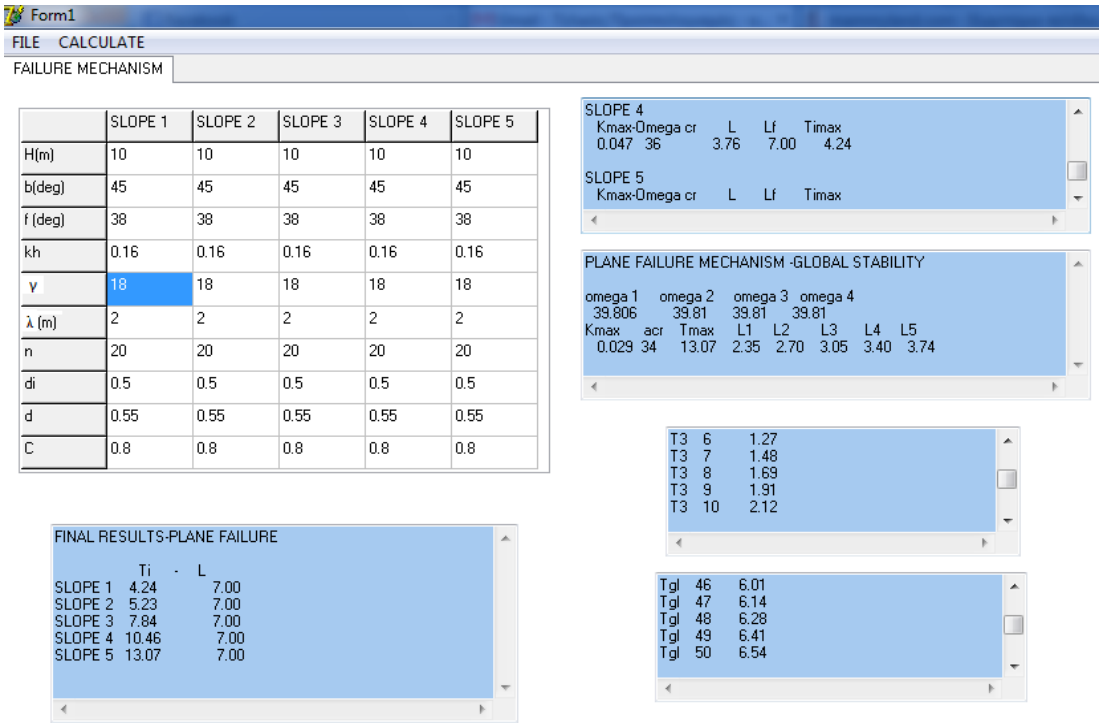
$$G_2 = \left[\frac{H_2+2H_3+2H_4+\ldots+2H_n}{\tan\Omega_{gl}} - \frac{H_2}{\tan\beta_2} - \frac{2H_3}{\tan\beta_3} - \frac{2H_4}{\tan\beta_4} - \frac{2H_n}{\tan\beta_n} - 2\lambda_2 - 2\lambda_3 - \ldots - 2\lambda_{n-1}\right]\gamma_2\frac{H_2}{2}$$

$$G_n = \left[\frac{H_n}{\tan \Omega_{gl}} - \frac{H_n}{\tan \beta_n} \right] \gamma_n \frac{H_n}{2}$$

$$G_i = \left[\frac{H_i + 2H_{i+1} + 2H_{i+2} + \ldots + 2H_n}{\tan \Omega_{gl}} - \frac{H_i}{\tan \beta_i} - \frac{2H_{i+1}}{\tan \beta_{i+1}} - \frac{2H_{i+2}}{\tan \beta_{i+2}} - \frac{2H_n}{\tan \beta_n} - 2\lambda_i - 2\lambda_{i+1} - \ldots - 2\lambda_{n-1} \right] \gamma_i \frac{H_i}{2}$$

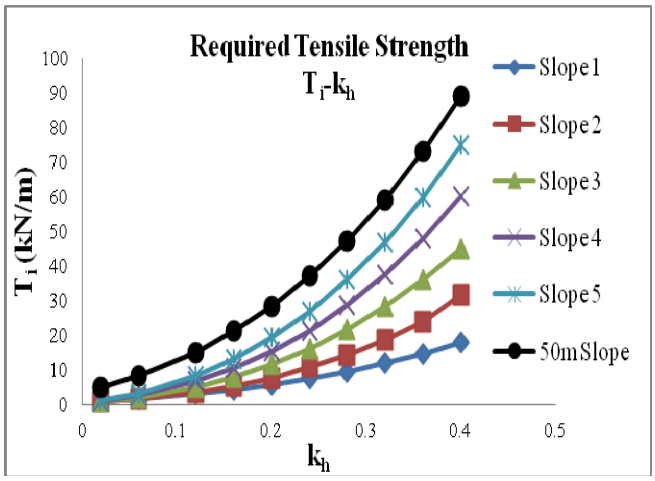
Επιπλέον, η απόσταση μεταξύ της επιφάνειας αστοχίας και της όψης του πρανούς είναι ίση με:

$$l_i = \frac{H_i + H_{i+1} + \ldots + H_n}{\tan(\Omega_i)} - \frac{H_i}{\tan(\beta_i)} - \frac{H_{i+1}}{\tan(\beta_{i+1})} - \ldots - \frac{H_n}{\tan(\beta_n)} - \lambda_i - \lambda_{i+1} \ldots - \lambda_{n-1}$$



	SLOPE 1	SLOPE 2	SLOPE 3	SLOPE 4	SLOPE 5
H(m)	10	10	10	10	10
b(deg)	45	45	45	45	45
f (deg)	38	38	38	38	38
kh	0.16	0.16	0.16	0.16	0.16
γ	18	18	18	18	18
λ (m)	2	2	2	2	2
n	20	20	20	20	20
di	0.5	0.5	0.5	0.5	0.5
d	0.55	0.55	0.55	0.55	0.55
C	0.8	0.8	0.8	0.8	0.8

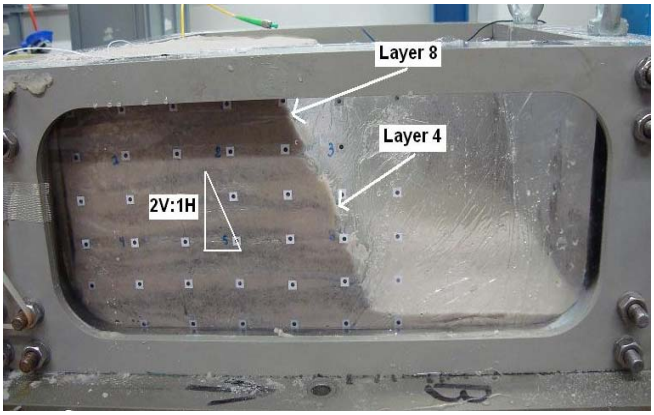
Σχήμα 2. Λογισμικό για αντισεισμικό σχεδιασμό βαθμιδωτού οπλισμένου πρανούς



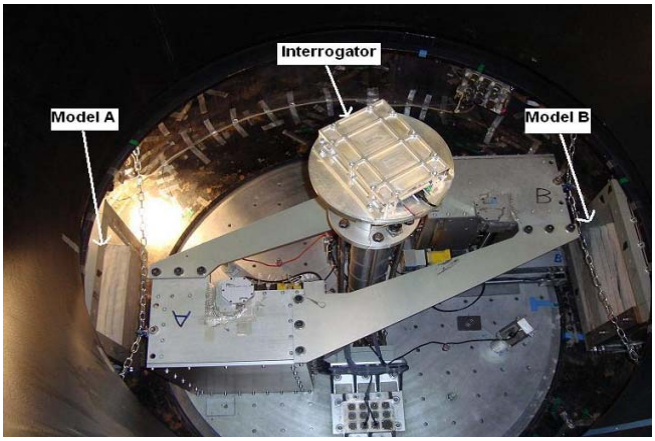
Σχήμα 3. Παράδειγμα απαιτούμενης αντοχής ενιαίου και βαθμιδωτού οπλισμένου πρανούς για διάφορες τιμές του kh.

*Η αναλυτική διερεύνηση πραγματοποιήθηκε με την στήριξη (υποτροφία) του **"Geosynthetic Institute" (GSI)**, Ινστιτούτου που εδρεύει στις Η.Π.Α., ενδιαφερόμενο για θέματα Γεωσυνθετικών, στα πλαίσια παγκόσμιας προκήρυξης-διαγωνισμού που πραγματοποιήθηκε για την ενίσχυση νέων ερευνητών που εκπονούν Διδακτορική Διατριβή σε θέματα γεωσυνθετικών. Δύο υποτροφίες δόθηκαν παγκοσμίως σε νέους ερευνητές εκτός Η.Π.Α. και τρεις εντός Η.Π.Α. Η έρευνα υποστηρίχθηκε για 3 συνεχόμενα χρόνια (2008-2011), με ξεχωριστή υποβολή υποψηφιότητας και κρίση ανά έτος.*

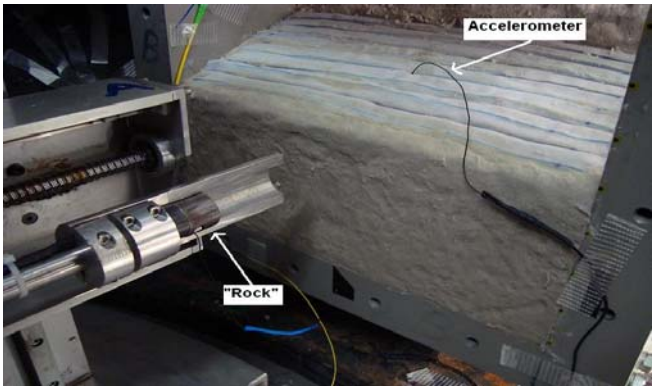
Ακολούθως πραγματοποιήθηκε **πειραματική διερεύνηση** όπου και κατασκευάσθηκαν συνολικά 16 μοντέλα οπλισμένων πρανών, υπό κλίμακα 1:50 και 1:100, τα οποία και τοποθετήθηκαν στον διαμέτρου 2.2 m γεωτεχνικό φυγοκεντριστή με τύμπανο του ETH Zurich. Στα μοντέλα ενσωματώθηκαν με επιτυχία αισθητήρες οπτικών ινών για πρώτη φορά, εισάγοντας μία νέα μετρητική διάταξη για την καταγραφή τροπών σε γεωτεχνικά μοντέλα τα οποία μελετώνται μέσω της τεχνολογίας των γεωτεχνικών φυγοκεντριστών. Επίσης, εφαρμόσθηκε η οπτική μέθοδος παρακολούθησης Particle Image Velocimetry Analysis (PIV Analysis). Τέλος, πραγματοποιήθηκε υπολογιστική διερεύνηση οπλισμένων πρανών σε κλίμακα 1:1 και τα αποτελέσματα συγκρίθηκαν με τα αντίστοιχα πειραματικά αποτελέσματα των φυσικών μοντέλων υπό κλίμακα 1:50 και 1:100.



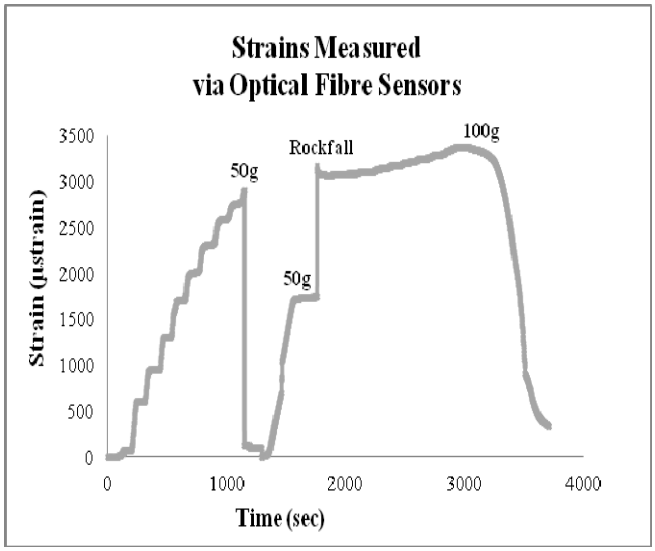
Φωτογραφία 1. Οπλισμένο πρανές υπό κλίμακα και ύψος H=18 cm (Kapogianni et al. 2010).



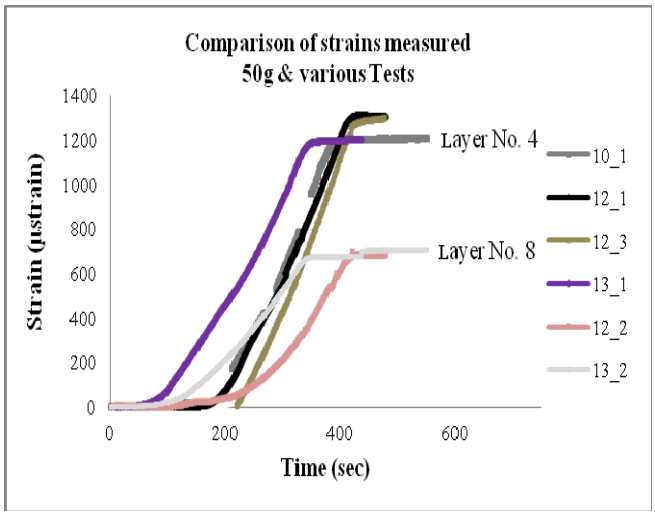
Φωτογραφία 2. Οπλισμένα πρανή στον γεωτεχνικό φυγοκεντριστή.



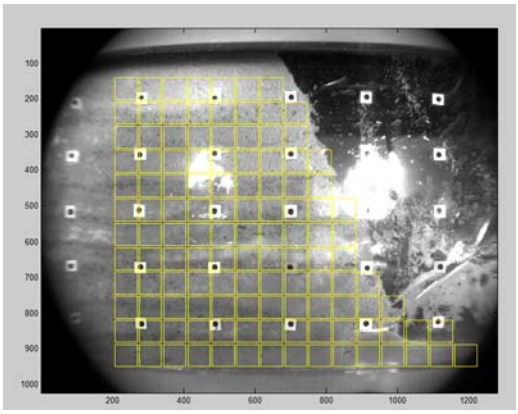
Φωτογραφία 3. Οπλισμένο πρανές υποβαλλόμενο σε βραχόπτωση.



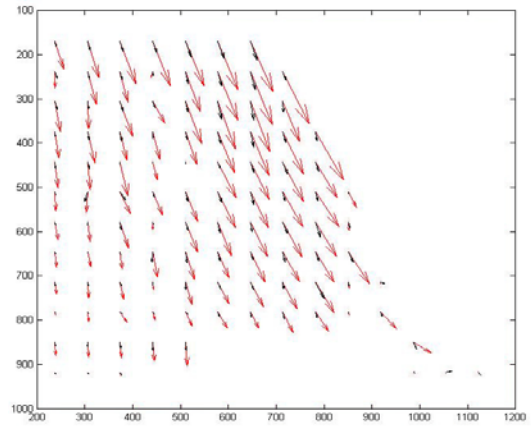
Σχήμα 4. Μετρήσεις μέσω αισθητήρων οπτικών ινών για διάφορες φάσεις φορτίσεων στον γεωτεχνικό φυγοκεντριστή.



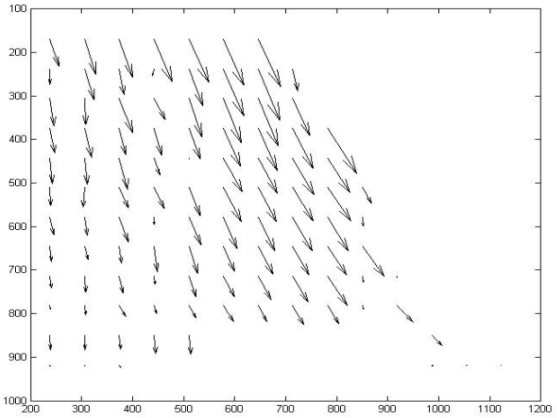
Σχήμα 5. Μετρήσεις μέσω αισθητήρων οπτικών ινών σε διάφορες θέσεις στο πρανές.



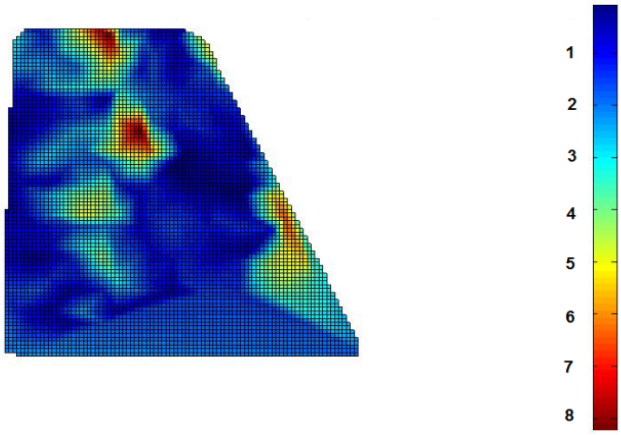
Σχήμα 6. Περιοχή ενδιαφέροντος (GeoPIV).



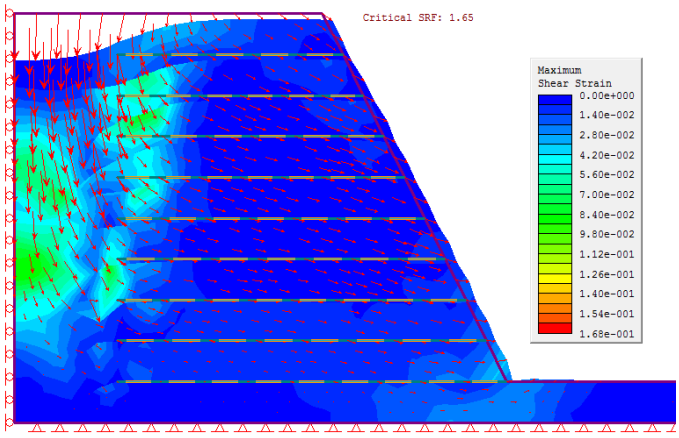
Σχήμα 7. Αρχική και τελική θέση πρανούς.



Σχήμα 8. Διανύσματα ροής μέσω GeoPIV.



Σχήμα 9. Αντίστοιχες τροπές (GeoPIV).



Σχήμα 10. Προσδιορισμός μηχανισμού αστοχίας και διατμητικών τροπών μέσω υπολογιστικών μοντέλων.

*Η πειραματική διερεύνηση των οπλισμένων πρανών στον γεωτεχνικό φυγοκεντριστή του ETH Zurich πραγματοποιήθηκε με την στήριξη-υποτροφία της **Ελβετικής Κυβέρνησης (Budesstipendium)** για την χρονική περίοδο 2008-2009, με συμμετοχή ως «επισκέπτρια Υποψήφια Διδάκτωρ του ETH Zurich». Κατά την χρονική περίοδο αυτή, επιβλέποντες Καθηγητές ήταν οι Prof. Sarah M. Springman και ο Dr. Jan Laue, σε συνεργασία με τον επιβλέποντα Καθηγητή κ. Μ. Σακελλαρίου.*

ΔΙΑΚΡΙΣΕΙΣ ΕΛΛΗΝΩΝ ΓΕΩΜΗΧΑΝΙΚΩΝ ΚΑΙ ΓΕΩΕΠΙΣΤΗΜΟΝΩΝ

Γιάννης Αναστασόπουλος

Το μέλος της ΕΕΕΕΓΜ Δρ. Γιάννης Αναστασόπουλος, Επίκουρος Καθηγητής του Τομέα Γεωτεχνικής της Σχολής Πολιτικών Μηχανικών του Εθνικού Μετσοβίου Πολυτεχνείου εξελέγη ως **Professor in Civil Engineering** στο Department of Civil Engineering - School of Engineering, Physics and Mathematics - College of Art, Science & Engineering του **University of Dundee** του Ηνωμένου Βασιλείου.

Δημήτρης Καραμήτρος

Το μέλος της ΕΕΕΕΓΜ Δρ. Δημήτρης Καραμήτρος εξελέγη **Lecturer in Civil Engineering**, στο Department of Civil Engineering - Queen's School of Engineering του **University of Bristol** του Ηνωμένου Βασιλείου και αναλαμβάνει καθήκοντα την 1η Αυγούστου ως μέλος του Earthquake and Geotechnical Engineering Research Group.

Κωνσταντίνος Λουπασάκης

Το μέλος της ΕΕΕΕΓΜ Δρ. Κωνσταντίνος Λουπασάκης, Λέκτορας του Τομέα Γεωλογικών Επιστημών της **Σχολής Μηχανικών Μεταλλείων – Μεταλλουργών του Εθνικού Μετσοβίου Πολυτεχνείου** εξελέγη στην βαθμίδα του **Επίκουρου Καθηγητή** στην ίδια Σχολή.

Βασίλης Μαρίνος

Το μέλος της ΕΕΕΕΓΜ Δρ. Βασίλης Μαρίνος, Λέκτορας του Τομέα Γεωλογίας του **Τμήματος Γεωλογίας του Αριστοτελείου Πανεπιστημίου Θεσσαλονίκης** εξελέγη στην βαθμίδα του **Επίκουρου Καθηγητή** στο ίδιο Τμήμα.

Κώστας Σαχπάζης

Το μέλος της ΕΕΕΕΓΜ Δρ. Κώστας Σαχπάζης, Γεωλόγος, ολοκλήρωσε τις σπουδές του στο Τμήμα Πολιτικών Μηχανικών του University of Portsmouth της Μεγάλης Βρετανίας με διάκριση (BEng (Hons)), κατατασσόμενος πρώτος μεταξύ των 120 αποφοιτησάντων. Επίσης ο Δρ. Σαχπάζης έλαβε από το Institution of Civil Engineers το 2013 ICE Student Prize για το Portsmouth University. Το βραβείο απονέμεται στον καλύτερο σπουδαστή Πολιτικό Μηχανικό του κάθε πανεπιστημίου που συμμετέχει στον σχετικό διαγωνισμό και βασίζεται όχι μόνο στην βαθμολογία των τελικών εξετάσεων, αλλά λαμβάνει υπ' όψη την εργασία του σπουδαστού κατά την διάρκεια του έτους καθώς και την ικανότητά του να σχεδιάζη κατασκευές πολιτικού μηχανικού.

ΘΕΣΕΙΣ ΕΡΓΑΣΙΑΣ ΓΙΑ ΓΕΩΕΠΙΣΤΗΜΟΝΕΣ

ΠΟΛΥΤΕΧΝΕΙΟ ΚΡΗΤΗΣ
ΕΡΕΥΝΗΤΙΚΟ ΠΡΟΓΡΑΜΜΑ «ΘΑΛΗΣ»

Το προσεχές διάστημα πρόκειται να δημοσιευθή πρόσκληση ενδιαφέροντος για τη σύναψη σύμβασης έργου Ιδιωτικού Δικαίου στο πλαίσιο ερευνητικού έργου (Πρόγραμμα «ΘΑΛΗΣ»).

Η θέση απασχόλησης θα αφορά σε Γεωλόγο / Μηχανικό Ορυκτών Πόρων / Πολιτικό Μηχανικό με εξειδίκευση στη Γεωτεχνική ή συναφές αντικείμενο. Η διάρκεια απασχόλησης θα είναι 12 μήνες, με δυνατότητα ανανέωσης για επιπλέον 12 μήνες. Η αμοιβή για τη διάρκεια απασχόλησης των 12 μηνών ανέρχεται στο ποσό των 14,000 ευρώ (συμπεριλαμβανομένου του ΦΠΑ).

Για περισσότερες πληροφορίες οι ανδιαφερόμενοι πρέπει να απευθυνθούν στον Επίκουρο Καθηγητή του Πολυτεχνείου Κρήτης Δρ. Ε. Στειακάκη, Εργαστήριο Εφαρμοσμένης Γεωλογίας, Χανιά, Τ.Κ. 73100, τηλ. 28210.37648, 28210.37894 τοτ. 28210.37894, ηλ.δι. stiakaki@mred.tuc.gr.

ΝΕΑ ΑΠΟ ΤΙΣ ΕΛΛΗΝΙΚΕΣ ΚΑΙ ΔΙΕΘΝΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΝΩΣΕΙΣ

ANNOUNCING THE GEOWORLD TECHNICAL FORUMS: GET ANSWERS TO YOUR TECHNICAL QUESTIONS FROM 3,000 GEOPROFESSIONALS!

Dear GeoWorld members,

We are very pleased to announce the official release of the Geo-Technical Forums that are now part of GeoWorld. The new forums were a request by many of you- individuals and committees of ISSMGE- and have features that aim to satisfy professional needs for communication about technical topics within the geo-community. This launch comes just a few weeks after YOU VOTED the Technical Forums as **the most needed online tool for geoprofessionals**.

The staff of Geoengineer.org has spent months working on the development of these new forums, which constitute at the same time a major upgrade of the forums previously available on Geoengineer.org. **They are now live and available for you at www.mygeoworld.info/forum/all**

There are a number of competitive advantages to the New GeoWorld Technical Forums, compared to other forums, including:

1. Unique *focus on technical issues* and organization per technical topic

2. Exceptionally high visibility and participation *by over 3,000 subscribed GeoWorld members*-among which are renowned geo-experts, both academicians and practitioners

3. Automatic tracking and indexing of content using tags, that categorize your thread and make it reach the right people so that visitors *in your particular field or area of interest will participate and answer your questions*

4. *Easier search* and more options for indexing. High visibility of the forums in search engines.

5. *Postings are tied to each individual's or company's/organization's GeoWorld account*. Members of GeoWorld *can establish a professional reputation by actively participating in the forums* and providing useful feedback to colleagues worldwide.

6. Active participants are eligible to receive free *books, conference registrations, and other professional geo-gifts*.

7. *As opposed to forums available elsewhere, as well as social media groups, these forums are shared with all members* (i.e., each group does not have its own forum) so that there is one central location where all questions are asked and answered!

So go ahead and check out the forums and post your questions! We look forward to receiving your feedback at admin@mygeoworld.info.

We hope you will share our enthusiasm for this groundbreaking forum board and that you will participate and get the most out of the GeoWorld Technical Forums!

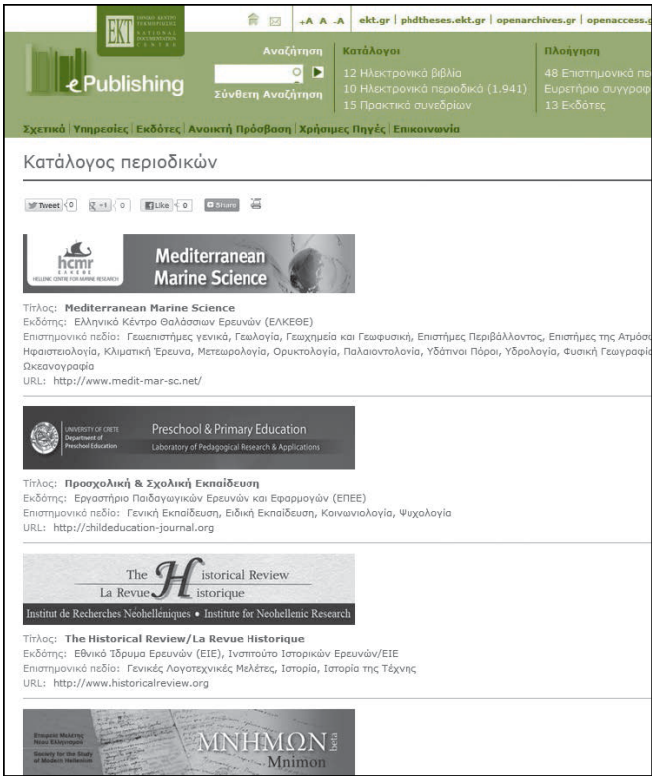
The GeoWorld Team

ΕΘΝΙΚΟ ΚΕΝΤΡΟ ΤΕΚΜΗΡΙΩΣΗΣ

Εθνικό Κέντρο Τεκμηρίωσης

Νέο διαδικτυακό περιβάλλον για τις **ηλεκτρονικές εκδόσεις του Εθνικού Κέντρου Τεκμηρίωσης**

Ένα νέο διαδικτυακό περιβάλλον για τις ηλεκτρονικές εκδόσεις του Εθνικού Κέντρου Τεκμηρίωσης (ΕΚΤ) λειτουργεί στη διεύθυνση **http://www.ekt.gr/epublishing**. Πρόκειται για μια δυναμική πλατφόρμα που φιλοξενεί τις ηλεκτρονικές εκδόσεις του ΕΚΤ, παρέχοντας ανοικτή πρόσβαση σε έγκριτα άρθρα ελληνικών επιστημονικών περιοδικών, καθώς και σε βιβλία και πρακτικά συνεδρίων από ένα ευρύ φάσμα επιστημονικών περιοχών. Στο νέο περιβάλλον ΕΚΤ ePublishing παρουσιάζονται οι Υπηρεσίες Ηλεκτρονικών Εκδόσεων του ΕΚΤ, με πληροφορίες για τους συνεργαζόμενους εκδότες.



Οι ηλεκτρονικές εκδόσεις του ΕΚΤ είναι αποτέλεσμα επιτυχημένων συνεργασιών του φορέα με Έλληνες επιστημονικούς εκδότες, διεθνούς κύρους, στις Ανθρωπιστικές, Κοινωνικές και Θετικές Επιστήμες. Με στόχο την προώθηση της γνώσης, την ανοικτή διάθεση των ερευνητικών αποτελεσμάτων και τη διεθνοποίηση της ελληνικής επιστημονικής παραγωγής, η πλατφόρμα ePublishing συγκεντρώνει σε ένα ενιαίο περιβάλλον τις ηλεκτρονικές εκδόσεις του ΕΚΤ και τις διαθέτει ανοικτά στο κοινό μέσα από προηγμένα συστήματα που αντλούν αυτόματα το περιεχόμενο των εκδόσεων, επιτρέπουν την εξειδικευμένη αναζήτηση στο υλικό αυτό και προσφέρουν μια ευχάριστη εμπειρία πλοήγησης.

Σήμερα, στην πλατφόρμα ΕΚΤ ePublishing φιλοξενείται έγκριτο επιστημονικό περιεχόμενο από 13 Έλληνες επιστημονικούς εκδότες (ανάμεσα τους τα Ινστιτούτα του Εθνικού Ιδρύματος Ερευνών, το Εθνικό Κέντρο Θαλάσσιων Ερευνών, η Χριστιανική Αρχαιολογική Εταιρεία, κ.ά.). Συγκεκριμένα, περιλαμβάνονται 8 έγκριτα επιστημονικά περιοδικά ανοικτής πρόσβασης (που ακολουθούν διαδικασίες επιστημονικής αξιολόγησης και ευρετηριάζονται σε διεθνείς βάσεις δεδομένων) με περισσότερα από 1.900 επιστημονικά άρθρα σε διάφορες γλώσσες, καθώς και περισσότερα από 25 ηλεκτρονικά βιβλία και πρακτικά συνεδρίων.

Οι αναγνώστες μπορούν να πλοηγηθούν σε ευρετήριο περίπου 1.800 συγγραφέων ή να αναζητήσουν το υλικό που τους ενδιαφέρει, επιλέγοντας από ένα πλούσιο κατάλογο επιστημονικών άρθρων και βιβλίων σε 48 επιστημονικά πεδία, από τις Κοινωνικές και Ανθρωπιστικές Επιστήμες (π.χ. Ιστορία, Αρχαιολογία) μέχρι τις Φυσικές και Γεωργικές Επιστήμες (π.χ. Θαλάσσια Βιολογία και Γεωεπιστήμες).

Το υλικό αυτό εμπλουτίζεται συνεχώς, καθώς το ΕΚΤ επεκτείνει το δίκτυο συνεργασιών του με επιστημονικούς εκδότες που επιθυμούν τη μετάβαση της έκδοσης τους σε διαδικτυακό περιβάλλον λειτουργίας και την οργάνωση της εκδοτικής διαδικασίας και παρουσίαση της έκδοσης, σύμφωνα με διεθνώς αναγνωρισμένα πρότυπα και τάσεις.

Το περιβάλλον του ΕΚΤ ePublishing οργανώνει το σύνολο των εκδόσεων του ΕΚΤ με τρόπο που όχι μόνο απλοποιεί την πλοήγηση, αλλά και επιτρέπει την ενιαία αναζήτηση στο πλήρες περιεχόμενο των βιβλίων, άρθρων και βιβλίων, με βάση λέξεις-κλειδιά. Η λειτουργία Σύνθετης Αναζήτησης παρέχει τη δυνατότητα να φιλτράρει κανείς τα αποτελέσματα αναζήτησης με βάση τον τύπο περιεχομένου (άρθρο, βιβλίο, περιοδικό, πρακτικά συνεδρίων), τον εκδότη, τον συγγραφέα, το επιστημονικό πεδίο κ.ά. Οι αναγνώστες έχουν τη δυνατότητα να διαβάσουν online το δημοσίευμα που τους ενδιαφέρει σε πολλαπλές μορφές (αρχείο, φυλλομέτρηση, online έκδοση κ.λπ.).

Όσο αφορά τα άρθρα σε επιστημονικά περιοδικά, το ΕΚΤ ePublishing ενσωματώνει το πλήρες κείμενο κάθε άρθρου, το οποίο προβάλλει στους χρήστες μαζί με επιπρόσθετες πληροφορίες μεταδεδομένων και συνδέσμους που συντελούν στη βέλτιστη αξιοποίηση του. Έτσι ο αναγνώστης μπορεί να μεταβεί σε άρθρα του ίδιου τεύχους, σχετικά άρθρα, έργα του ίδιου συγγραφέα, να πραγματοποιήσει αναζήτηση σε όλο το περιεχόμενο του ΕΚΤ ePublishing, να εξαγάγει την βιβλιογραφική αναφορά, να βρει επιπρόσθετες πληροφορίες για το ηλεκτρονικό περιοδικό (όπως οδηγίες για συγγραφείς ή σχετικά με την πολιτική του περιοδικού) αλλά και να υποβάλει ηλεκτρονικά την εργασία του στο περιοδικό.

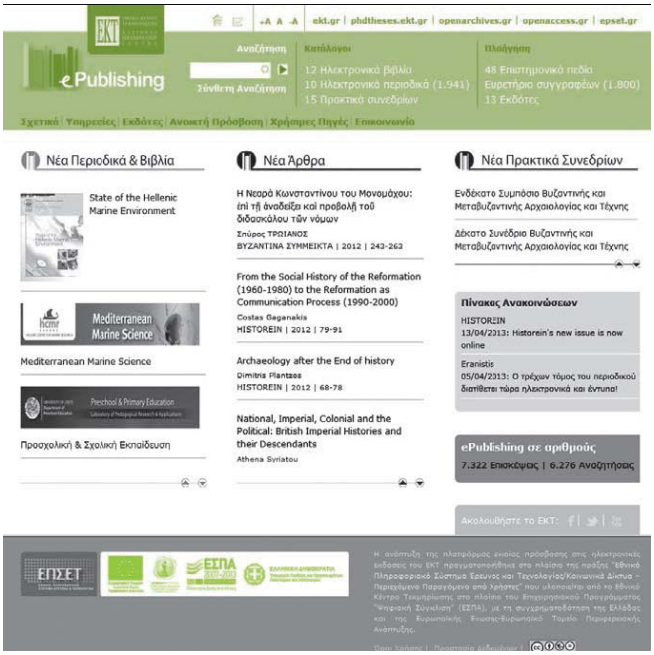
Παράλληλα, οι δυνητικοί συγγραφείς μπορούν να ενημερωθούν για τις δυνατότητες κατάθεσης επιστημονικών άρθρων στους συνεργαζόμενους εκδότες και τους κανονισμούς υποβολής εργασιών του κάθε εκδότη, καθώς και για τα οφέλη των δημοσιεύσεων με ανοικτή πρόσβαση.

Η πλατφόρμα ePublishing στεγάζει τις συνεχώς αναπτυσσόμενες υπηρεσίες ηλεκτρονικών εκδόσεων του ΕΚΤ, οι οποίες αξιοποιούν με συνέπεια την εμπειρία και τεχνογνωσία του φορέα και ακολουθούν τις τελευταίες εξελίξεις στην ακαδημαϊκή επικοινωνία για να προσφέρουν στους εκδότες και στους αναγνώστες εναλλακτικές μορφές έκδοσης και διάχειρισης της επιστημονικής παραγωγής.

Το ΕΚΤ παρέχει σειρά από υπηρεσίες ηλεκτρονικών εκδόσεων σε όλα τα στάδια της εκδοτικής δραστηριότητας -από την ψηφιοποίηση μέχρι τη δημοσιότητα- όπως: φιλοξενία του περιεχομένου σε servers του ΕΚΤ, υπηρεσίες ψηφιοποίησης και σχεδιασμού ψηφιακής έκδοσης, το λογισμικό ανοικτού κώδικα Open Journal Systems (OJS) για τη διαχείριση της εκδοτικής διαδικασίας επιστημονικών περιοδικών, υπηρεσίες οργάνωσης και τεκμηρίωσης περιεχομένου, συμβουλευτικές υπηρεσίες, τεχνική υποστήριξη, υπηρεσίες λογισμικού που εξασφαλίζουν συμβατότητα με σύγχρονες συσκευές ανάγνωσης, υπηρεσίες ευρετηριασμού σε διεθνείς βάσεις δεδο-

μένων (π.χ. Scopus, DOAJ, ISI) και υπηρεσίες προώθησης και προβολής.

Οι παραδειγματικές δράσεις και πρωτοβουλίες του ΕΚΤ για τις ηλεκτρονικές εκδόσεις απορρέουν από τον θεσμικό ρόλο του φορέα για τη συγκέντρωση και διάθεση με ανοικτή πρόσβαση της επιστημονικής παραγωγής της χώρας, και ενισχύουν το όραμα του φορέα να συμβάλει ουσιαστικά στη μετάβαση σε νέα μοντέλα ψηφιακής έρευνας (e-science) με όχημα την τεχνολογία. Ακόμη, στόχος του ΕΚΤ είναι να προωθήσει ουσιαστικά σε διεθνές επίπεδο και να καταστήσει άμεσα αξιοποιήσιμη την έγκριτη έρευνα που παράγεται στη χώρα μας.



Χαρακτηριστικά αναφέρεται ότι τα ηλεκτρονικά επιστημονικά περιοδικά προσήλκυσαν το 2012 περισσότερους από 45.000 μοναδικούς χρήστες από τουλάχιστον 130 χώρες στον κόσμο, ενώ σε πολλές περιπτώσεις η επισκεψιμότητα από το εξωτερικό φθάνει ή και ξεπερνά τα επίπεδα της επισκεψιμότητας από την Ελλάδα, αποδεικνύοντας τη διεθνή απήχηση που μπορεί να έχει η επιστημονική έρευνα στη χώρα μας.

Οι Υπηρεσίες Ηλεκτρονικών Εκδόσεων του ΕΚΤ αναπτύσσονται στο πλαίσιο του έργου "Εθνικό Πληροφοριακό Σύστημα Έρευνας και Τεχνολογίας (ΕΠΣΕΤ) - Κοινωνικά Δίκτυα και Περιεχόμενο Παραγόμενο από Χρήστες" (Επιχειρησιακό Πρόγραμμα "Ψηφιακή Σύγκλιση", ΕΣΠΑ, με τη συγχρηματοδότηση της Ελλάδας και της ΕΕ-Ευρωπαϊκό Ταμείο Περιφερειακής Ανάπτυξης) (www.epset.gr), που αποτελεί το κύριο αναπτυξιακό έργο του ΕΚΤ.

Info

Ηλεκτρονικές Εκδόσεις ΕΚΤ http://epublishing.ekt.gr/

Εθνικό Πληροφοριακό Σύστημα Έρευνας και Τεχνολογίας http://www.epset.gr/

Περιοδικό 'Καινοτομία, Έρευνα και Τεχνολογία'

Από τον Ιανουάριο του 1996, το Εθνικό Κέντρο Τεκμηρίωσης εκδίδει το περιοδικό "Καινοτομία, Έρευνα και Τεχνολογία". Πρόκειται για τριμηνιαία έκδοση (διμηνιαία την περίοδο Ιούλιος 2000 - Μάιος 2011) η οποία εντάσσεται στο πλαίσιο των δραστηριοτήτων του ΕΚΤ για την προώθηση της Έρευνας, της Τεχνολογίας και της Καινοτομίας.

http://www.ekt.gr/content/display?ses_mode=rnd&ses_lang=el&prnbr=3706

ΠΡΟΣΕΧΕΙΣ ΕΚΔΗΛΩΣΕΙΣ ΓΕΩΤΕΧΝΙΚΟΥ ΕΝΔΙΑΦΕΡΟΝΤΟΣ ΣΤΗΝ ΕΛΛΑΔΑ

2ο ΠΑΝΕΛΛΗΝΙΟ ΣΥΝΕΔΡΙΟ ΦΡΑΓΜΑΤΩΝ ΚΑΙ ΤΑΜΙΕΥΤΗΡΩΝ
Σχεδιασμός – Διαχείριση – Περιβάλλον
Αθήνα, 7 - 8 Νοεμβρίου 2013
http://waterstorage2013.com

Μετά το πολύ επιτυχημένο πρώτο συνέδριο στη Λάρισα το 2008, η Ελληνική Επιτροπή Μεγάλων Φραγμάτων (ΕΕΜΦ) διοργανώνει το **2ο Πανελλήνιο Συνέδριο Φραγμάτων και Ταμιευτήρων στις 7 & 8 Νοεμβρίου του 2013 στην Αθήνα, στην Αίγλη Ζαππείου**.

Η απαίτηση για ορθολογική διαχείριση του υδατικού δυναμικού είναι μεγαλύτερη παρά ποτέ. Στις αυξανόμενες ανάγκες για ύδρευση, άρδευση, ενέργεια και αντιπλημμυρική προστασία προστίθεται ολοένα και πιο επιτακτικά η ανάγκη για προστασία και επανατροφοδότηση των υπόγειων υδροφορέων και η αναβάθμιση και προστασία των ποτάμιων και λιμναίων οικοσυστημάτων.

Ο ρόλος των φραγμάτων και ταμιευτήρων είναι κομβικός για την αντιμετώπιση των ανωτέρω. Η χώρα μας, αν και καθυστέρησε σημαντικά στην εκμετάλλευση του υδάτινου δυναμικού, έχει κατασκευάσει τις τελευταίες δεκαετίες μεγάλο αριθμό φραγμάτων, και ταμιευτήρων, ενώ ένας μεγάλος αριθμός νέων έργων είναι τώρα σε φάση μελέτης ή υλοποίησης.

Τα φράγματα και οι ταμιευτήρες είναι πολύπλοκα έργα με πολλές συνιστώσες που δημιουργούν αυξημένες απαιτήσεις κατά το σχεδιασμό, την υλοποίηση και τη λειτουργία τους. Ο σεβασμός στο περιβάλλον, η ολοκληρωμένη διαχείριση των υδατικών πόρων, η χρήση νέων τεχνολογιών, η μακροχρόνια συμπεριφορά και ασφάλεια, η ευθύνη του κυρίου του έργου ή του διαχειριστή για την ασφαλή λειτουργία των έργων, είναι θέματα στα οποία θα επικεντρωθούν οι εργασίες του συνεδρίου.

Το συνέδριο στοχεύει στην παρουσίαση, ανάδειξη και συζήτηση των ανωτέρω ζητημάτων και απευθύνεται σε όλους όσοι με την μελέτη, κατασκευή και διαχείριση έργων φραγμάτων και ταμιευτήρων.

Θεματολόγιο

1. Φράγματα και Ολοκληρωμένη Διαχείριση Υδατικών Πόρων

- Ο ρόλος των ταμιευτήρων στην ολοκληρωμένη διαχείριση υδατικών πόρων
- Ταμιευτήρες πολλαπλού σκοπού
- Αντιπλημμυρική προστασία
- Τεχνικο-οικονομικά κριτήρια υλοποίησης νέων φραγμάτων
- Ο ρόλος των φραγμάτων στον ενεργειακό σχεδιασμό - Σύγχρονες τάσεις και τεχνολογικές εξελίξεις
- Ταμιευτήρες – Αντλητικά και υβριδικά συστήματα παραγωγής ενέργειας

2. Εξελίξεις στις Μεθόδους Σχεδιασμού & Κατασκευής

- Υλικά κατασκευής φραγμάτων - Μέθοδοι κατασκευής - Νέες τεχνικές
- Εκτίμηση, επιλογή και αναθεώρηση πλημμυρών σχεδιασμού
- Σχεδιασμός και αναβάθμιση υπερχειλιστών
- Έργα στεγάνωσης και αποστράγγισης φράγματος και θεμελίωσης
- Η επιρροή των γεωλογικών συνθηκών στον σχεδιασμό
- Εξελίξεις στον γεωτεχνικό σχεδιασμό
- Εξελίξεις στον αντισεισμικό σχεδιασμό
- Εξελίξεις στον Η/Μ εξοπλισμό

3. Ασφάλεια Φραγμάτων και Ταμιευτήρων

- Κανονισμοί μελέτης, κατασκευής και λειτουργίας φραγμάτων
- Η πρόταση της ΕΕΜΦ για την σύνταξη εθνικού κανονισμού ασφάλειας φραγμάτων
- Αποτίμηση της διακινδύνευσης φραγμάτων (risk assessment)
- Δημόσιοι και ιδιωτικοί φορείς εμπλεκόμενοι στη διαχείριση φραγμάτων – θέματα οργάνωσης και τεχνικής ικανότητας
- Κίνδυνοι σχετιζόμενοι με προβλήματα οργάνωσης του κυρίου - διαχειριστή του έργου
- Απαιτήσεις παρακολούθησης συμπεριφοράς
- Ασφάλεια ταμιευτήρα (ευστάθεια πρανών, εκτεταμένες διαρροές κτλ)
- Αναλύσεις θραύσης φράγματος και επιπτώσεις
- Μακροχρόνια συμπεριφορά, γήρανση των έργων και εργασίες αποκατάστασης
- Κίνδυνοι οφειλόμενοι σε αστοχίες Η/Μ εξοπλισμού
- Παρουσίαση πρόσφατων συμβάντων ή περιστατικών
- Φράγματα, ταμιευτήρες και δημόσια ασφάλεια
- Ασφαλής παροχέτευση εκτάκτων πλημμυρικών παροχών κατάντη – απαιτήσεις οριοθέτησης της κοίτης

4. Φράγματα, Ταμιευτήρες και Περιβάλλον

- Φιλικές προς το περιβάλλον κατασκευές φραγμάτων και ταμιευτήρων
- Φράγματα, ταμιευτήρες και αειφορία
- Περιβαλλοντική και κοινωνικά αποδοχή φραγμάτων και ταμιευτήρων – Συμμετοχικές διαδικασίες στο σχεδιασμό και υλοποίηση
- Περιορισμός υδρομορφολογικών αλλοιώσεων και αισθητική αποκατάσταση περιβάλλοντος
- Αρχιτεκτονικός σχεδιασμός φραγμάτων και συναφών κατασκευών
- Τα φράγματα ως μέρος της πολιτιστικής κληρονομιάς
- Εμπλουτισμός και αποκατάσταση υπόγειων υδροφορέων - Δημιουργία υγροβιότοπων κ.λπ.
- Χρονική εξέλιξη των ποιοτικών χαρακτηριστικών των ταμιευτήρων - Διατήρηση και βελτίωση ποιότητας υδατικών πόρων
- Φερτές ύλες

5. Παρουσίαση έργων

Κρίσιμες ημερομηνίες για την αποστολή εργασιών:

- Υποβολή περιλήψεων: **15 Δεκεμβρίου 2012**
- Αποδοχή περιλήψεων: **15 Ιανουαρίου 2013**
- Υποβολή πλήρους κειμένου: **30 Απριλίου 2013**
- Αποδοχή πλήρους κειμένου: **30 Ιουνίου 2013**

Οδηγίες για την αποστολή των περιλήψεων θα βρείτε στη ιστοσελίδα της ΕΕΜΦ www.eemf.gr.

Οι περιλήψεις θα αποστέλλονται ηλεκτρονικά στην διεύθυνση της ΕΕΜΦ eemf@eemf.gr.

ΕΛΛΗΝΙΚΗ ΕΠΙΤΡΟΠΗ ΜΕΓΑΛΩΝ ΦΡΑΓΜΑΤΩΝ, μέσω ΔΕΗ – ΔΥΗΠ, Αγησιλάου 56-58, 104 36 ΑΘΗΝΑ, τοτ. 210 - 5241223, Η/Δ : eemf@eemf.gr, www.eemf.gr

6° ΠΑΝΕΛΛΗΝΙΟ ΣΥΝΕΔΡΙΟ ΛΙΜΕΝΙΚΩΝ ΕΡΓΩΝ
Αθήνα 11 - 14 Νοεμβρίου 2013

Το Εργαστήριο Λιμενικών Έργων του Ε.Μ.Π. διοργανώνει το 6° ΠΑΝΕΛΛΗΝΙΟ ΣΥΝΕΔΡΙΟ ΛΙΜΕΝΙΚΩΝ ΕΡΓΩΝ. Θα πραγματοποιηθεί στην Αθήνα στις 11-14 Νοεμβρίου 2013.

Αντικείμενο του Συνεδρίου είναι η παρουσίαση των νεοτέρων εξελίξεων στο χώρο των επιστημών και των τεχνολογιών που σχετίζονται με τα Λιμενικά Έργα και ειδικότερα την έρευνα, τον σχεδιασμό, την μελέτη, κατασκευή, προστασία, συντήρηση, διαχείριση, στις επιπτώσεις στο περιβάλλον καθώς και η ενημέρωση, η ανταλλαγή απόψεων και η προώθηση της τεχνογνωσίας στους τομείς αυτούς. Στόχος του είναι η ενημέρωση, η ανταλλαγή απόψεων και η προώθηση της τεχνογνωσίας.

Απευθύνεται στους ερευνητές, μελετητές, κατασκευαστές, ΑΕΙ, δημόσιους φορείς, ΟΤΑ, Ο.Λ., Λιμενικά Ταμεία, περιβαλλοντικές οργανώσεις και υπηρεσίες που ενδιαφέρονται και ασχολούνται με τα Λιμενικά Έργα, τους οποίους και προσκαλεί να παρουσιάσουν το έργο και τις εμπειρίες τους.

Θεματολόγιο

- Περιβαλλοντικά μεγέθη σχεδιασμού και κατασκευής λιμενικών έργων
- Σχεδιασμός λιμένων, μελέτη και κατασκευή λιμενικών έργων
- Χωροθέτηση λειτουργιών, διαμόρφωση λιμενικής ζώνης
- Αστοχίες, βλάβες λιμενικών έργων. Επιθεώρηση, αποκατάσταση, συντήρηση
- Μελέτη λιμένων σε φυσικό προσομοίωμα
- Περιβαλλοντικές επιπτώσεις από την κατασκευή και λειτουργία λιμένων
- Το Ελληνικό Λιμενικό Σύστημα υπό το πρίσμα της Ευρωπαϊκής οικονομικής κρίσης
- Διαχείριση, διοίκηση, λειτουργία λιμένων. Θεσμικό πλαίσιο. Ιδιωτικοποιήσεις δραστηριοτήτων.

Οι ενδιαφερόμενοι για περισσότερες πληροφορίες μπορούν να απευθύνονται στο Εργαστήριο Λιμενικών Έργων Ε.Μ.Π. τηλ.: 210.7722367, 210.7722375, 210.7722371, fax: 210. 7722368 (κες Θ. Γιαντσή, Ι. Φατούρου).

e-mail: lhw@central.ntua.gr

30 September - 3 October 2014, Athens, Greece
www.eetc2014athens.org

It is our pleasure to inform you that the Greek Tunnelling Society is organizing the 2nd Eastern European Tunnelling Conference in Athens on September 28 – October 1 2014 (EETC2014, Athens).

The Eastern European Tunnelling Conference is a biennial regional traveling conference. It aims to promote the sharing of knowledge, experience, skills, ideas and achievements in the design, financing and contracting, construction, operation and maintenance of tunnels and other underground facilities among the countries of Eastern Europe, on an organized basis and with agreed aims. EETC2014 aims mainly to bring together colleagues from Eastern Europe but people from the rest of the world are also welcome.

The theme of EETC2014 Athens is:

"Tunnelling in a Challenging Environment"
Making tunnelling business in difficult times

The construction of underground projects is becoming increasingly demanding as new challenges are emerging in every aspect and sector of this multidisciplinary and multifarious business. Further to the usual geological, geotechnical, structural and operational challenges, we are now facing a difficult business and financial environment, which requires the deployment of even more intelligent and effective tools and solutions.

I really do hope that the EETC2014 Athens will contribute and further facilitate the growth of the tunnelling business and will be a forum for scientific and professional collaboration.

TOPICS:

- Innovative methods for Analysis and Design
- Tunnelling in difficult ground conditions
- Conventional urban or shallow tunnelling
- Mechanized tunnelling
- Hydraulic tunnels
- Underground complexes
- Caverns for Hydropower or Storage
- Pipe jacking and microtunnelling
- Innovations in tunnelling construction technology
- Tunnels and shafts for mining
- Rehabilitation and repair
- Safety and security in tunnels and tunnelling
- Contractual and financial issues
- Education and training
- Case histories
- Underground space use
- Tunnels and monuments

ΠΡΟΣΕΧΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΚΔΗΛΩΣΕΙΣ

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

The 6th International Symposium on Rock Stress, 20-22 August 2013, Sendai, Japan, http://www2.kankyo.tohoku.ac.jp/rs2013

The Third International Symposium on Computational Geomechanics (ComGeo III), Krakow, Poland, 21-23 August, 2013, www.ic2e.org/index.php/comgeo/comgeo-iii

5th International Young Geotechnical Engineers' Conference (5iYGEC'13), 31 August - 01 September 2013, Paris, France http://www.lepublicsystemepco.com/EN/events.php?IDManif=696&IDModule=21&PPAGE=&PAGE=&TEMPLATE=&CSS=&IDRub

18th International Conference on Soil Mechanics and Geotechnical Engineering "Challenges and Innovations in Geotechnics", 1 – 5 September 2013, Paris, France www.paris2013-icsmge.org

13th International Conference of the Geological Society of Greece, September 5-8 2013, Chania, Greece, www.ege13.gr

Géotechnique Symposium in Print on Bio- and Chemo-Mechanical Processes in Geotechnical Engineering, www.elabs10.com/content/2010001471/SIP%202013.pdf

EUROCK 2013 ISRM European Regional Symposium "Rock Mechanics for Resources, Energy and Environment", 21-26 September 2013, Wroclaw, Poland www.eurock2013.pwr.wroc.pl

International Symposium & 9th Asian Regional Conference of IAEG Global View of Engineering Geology and the Environment, 24 - 25 September, 2013, Beijing, China, www.iaegasia2013.com

Piling & Deep Foundations Asia, 25 - 26 September, 2013, Kuala Lumpur, Malaysia, www.pilingdeepfoundationsasia.com

Sardinia_2013 14th International Waste Management and Landfill Symposium, 30 September – 4 October 2013, Sardinia, Italy, www.sardiniasymposium.it

HYDRO 2013 International Conference and Exhibition Promoting the Versatile Role of Hydro, 7 to 9 October 2013, Innsbruck, Austria, www.hydropower-dams.com/hydro-2013.php?c_id=88

VAJONT 2013 - International Conference Vajont, 1963 – 2013 Thoughts and Analyses after 50 years since the catastrophic landslide, 8-10 October, 2013, Padova, Italy, http://www.vajont2013.info/vajont-pd

The 5th International Conference on Geoinformation Technologies for Natural Disaster Management (GiT4NDM 2013), October 9 – 11, Ontario, Canada, www.igrdg.com/5thGiT4NDM.php

The 1st International Symposium on Transportation Soil Engineering in Cold Regions - A Joint Conference with the 10th SHAHUNIANTS Lecture, October 10-11, 2013, Xining, China, http://subgrade.sinaapp.com

International Symposium on Design and Practice of Geosynthetic-Reinforced Soil Structures, 13-16 October, 2013, Bologna, Italy, www.civil.columbia.edu/bologna2013

The Mediterranean Workshop on Landslides: Landslides in hard soils and weak rocks - an open problem for Mediterranean countries, 21 and 22 October, 2013, Naples, Italy, www.mwl.unina2.it

International Conference Geotechnics in Belarus: Science and Practice, 23-25 October 2013, Minsk, Belarus, geotechnika2013@gmail.com belgeotech@tut.by

6th International Conference GEOSYNTHETICS MIDDLE EAST 2013

GeoME 2013

6th International Conference

GEOSYNTHETICS Middle East

29 - 30 October 2013, Abu Dhabi, UAE

www.geosyntheticsme.com

Under the Patronage of the Municipality of Abu Dhabi city, the conference has turned out to be the leading event on geosynthetics throughout the Middle East and marked Abu Dhabi on the world map as an excellent meeting place for geotechnical and environment specialists to exchange knowledge, conduct business and build strategic partnerships. By sponsoring the 6th edition of Middle East's largest geosynthetics event, the Municipality of Abu Dhabi City has once again proved its real commitment to a sustainable and environment friendly infrastructure in line with the 2030 vision of the United Arab Emirates.

Organized by SKZ the German Plastics Centre, the conference is taking place on 29th and 30th October 2013 in Abu Dhabi, UAE.

With a main focus on the region's Transportation Infrastructure as well as Greening Solutions, this event will provide a highly attractive platform for international geotechnical and environmental specialists to exchange their knowledge and experience. Key industry experts will present applications & case studies on geosynthetics used in: Railways, Roads, Airports, Seaports, Bridges, Tunnels, Landfills, Environmental Protection and other related topics.

The conference will be associated with a technical exhibition, where national and international companies are showcasing their products and services in: Geosynthetics, Geotextiles, Geomembranes, Waterproofing Membranes, Geosynthetic Clay Liners (GCL), Geogrids, Geonets, Geocomposites, Geofoam, Geocells, Geopipes, Water Management Systems, Leachate Collection Systems, Irrigation Solutions, Erosion Controls and many more.

Hydropower 2013--CHINCOLD 2013 Annual Meeting and the 3rd International Symposium on Rockfill Dams, 1-3 November 2013, Kunming, China http://www.chincold.org.cn/dams/special/A2022index_1.htm

Problems and experience of the engineering protection of the urbanized territories and a safeguarding of the heritage under conditions of the geo-ecological risk, 5-7 November 2013, Kyiv, Ukraine, http://new.sophiakievska.org/en

IRF 17th World Meeting & Exhibition, November 9 - 13, 2013, Riyadh, Saudi Arabia, www.IRF2013.org

6th Annual Bridges Middle East & Tunnels Middle East, 11 - 13 November, 2013 - Doha, Qatar, www.bridgesme.com

Invitation to Workshop
Dams: Incidents and Accidents – What Can We Learn?"
November 11-13, 2013, Stockholm, Sweden
www.conferencemanager.dk/swedcold

The European Club of ICOLD (International Commission on Large Dams), together with the Swedish National Committee of ICOLD, is organizing a **workshop** with title **"Dams: Incidents and Accidents – What Can We Learn?".**

This workshop will focus on lessons learnt from dam incidents and accidents, mainly in Europe, but also from other parts of the world. Areas covered will include different types of dams, such as concrete dams, earth dams, tailings dams, as well as important subsystems such as gates and control systems. The typical attendee will be engineers, dam owners, consultants, regulators, etc.

The workshop will be divided in different sessions and each presentation will be given ample time (40-45 min) to be able to include more details than would usually be the case, and there will be a good opportunity to discuss and debate in connection to each presentation.

Interested speakers are invited to submit their cases to the Organizing Committee before September 12, 2013 to the following address: swedcold@sweco.se.

A full-day study trip on November 13 to the Älvkarleby HPP, 200 km north of Stockholm, is being also organized, which will include a visit to the hydraulic laboratories of Vattenfall.

Further information on hotel reservation procedures can be found in the workshop website:
http://www.conferencemanager.dk/swedcold

6° ΠΑΝΕΛΛΗΝΙΟ ΣΥΝΕΔΡΙΟ ΛΙΜΕΝΙΚΩΝ ΕΡΓΩΝ, Αθήνα 11 - 14 Νοεμβρίου 2013, lhw@central.ntua.gr

GEOMATE 2013 3rd International Conference on Geotechnique, Construction Materials & Environment, November 13-15, 2013, Nagoya, Japan, www.geomat-e.com

International Conference Built Heritage 2013 - Monitoring Conservation Management, 18-20 November 2013, Milano, Italy, www.bh2013.polimi.it

GEOAFRICA2013 Geosynthetics for Sustainable Development in Africa - 2nd African Regional Conference on Geosynthetics, 18-20 November 2013, Accra, Ghana, http://geoafrica2013.com

10th International Symposium of Structures, Geotechnics and Construction Materials, 26-29 November 2013, Santa Clara, Cuba, ana@uclv.edu.cu, quevedo@uclv.edu.cu, www.uclv.edu.cu

International Conference on Geotechnics for Sustainable Development, 28-29 November 2013, Hanoi, Vietnam, www.geotechn2013.vn

ISAFE2013 International Symposium on Advances in Foundation Engineering, 5-6 December 2013, Singapore, http://rpsonline.com.sg/isafe2013

Arabian Tunnelling Conference & Exhibition, 10-11 December 2013, Dubai, United Arab Emirates, http://uae-atc2013.com

8th International Conference Physical Modelling in Geotechnics 2014, 14-17 January 2014, Perth, Australia, http://icpmg2014.com.au

ANDORRA 2014 14th International Winter Road Congress 2014, 4-7 February 2014, Andorra la Vella (Andorra), www.aipcrandorra2014.org

Fifth International Conference on Water Resources and Hydropower Development in Asia
11 to 13 March 2014, Colombo, Sri Lanka
http://www.hydropower-dams.com/ASIA-2014.php?c_id=89

The ASIA 2014 Conference and Exhibition will bring together experts in all the disciplines associated with planning, financing, implementing, operating and refurbishing dams and hydro plants. Delegations from more than 60 countries are expected to attend, and will exchange knowledge and experience on a broad range of topics of particular relevance to the Asian countries, such as policy and planning, project finance, design and construction of water infrastructure, flood management, sedimentation management, hydro plant design, safety, pumped storage, rural electrification, power trading and climate change adaptation.

Conference Thermes

- Potential and Planning
- Country overviews of potential and plans
- Development opportunities and incentives for investment
- Planning tools
- Regional collaboration and power trading
- Grid management

- Project Finance and Contractual Aspects
- Perspectives from international and regional financing agencies
- Assessing and mitigating risks
- New financing strategies
- Legal and contractual issues
- Incentives for the private sector
- Risk mitigation and management
- E&S management to secure project finance

- Environment & Social Issues
- Communications and stakeholder involvement
- Benefit sharing
- Employment opportunities and training
- Environmental management and mitigation measures
- Social cost of not implementing projects
- Resettlement planning and implementation

- Hydrology and Climate Issues
- Flood forecasting and management
- Hydrological modelling
- Climate change adaptation
- Flood discharge works
- The role of water infrastructure and storage

- Civil Engineering
- Designing appropriate water infrastructure
- Dam design: Innovations and experience
- Dam safety
- Flood discharge works
- Sedimentation management

- Hydro Plants and Equipment
- Research and development
- Hydraulic turbine design
- Operation, maintenance and refurbishment
- Small and micro hydro
- Pumped storage
- Electrical engineering

- Multipurpose Storage Schemes
- Planning for multipurpose structures
- Combining hydro with irrigation/water supply
- Quantifying multipurpose benefits
- Water storage and food security

For more information please contact:

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Conference Project Manager,
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SM6 6AN, UK.
Tel: +44 20 8773 7244
Fax: + 44 20 8773 7255.
Email: asia2014@hydropower-dams.com

World Tunnel Congress 2014 and 40th ITA General Assembly "Tunnels for a better living", 9 - 15 May 2014, Iguassu Falls, Brazil, www.wtc2014.com.br

CPT'14 3rd International Symposium on Cone Penetration Testing, 13-14 May 2014, Las Vegas, Nevada, U.S.A., www.cpt14.com

International Conference on Piling & Deep Foundations, 21-23 May 2014, Stockholm, Sweden, www.dfi-effc2014.org

EUROCK 2014 ISRM European Regional Symposium Rock Engineering and Rock Mechanics: Structures on and in Rock Masses, 27-29 May 2014, Vigo, Spain, www.eurock2014.com

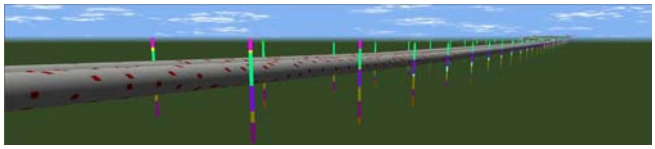
Geoshanghai 2014, International Conference on Geotechnical Engineering, 26 - 28 May 2014, Shanghai, China, www.geoshanghai2014.org

World Landslide Forum 3, 2 – 6 June 2014, Beijing, China, http://wlf3.professional.com

8th European Conference "Numerical Methods in Geotechnical Engineering" NUMGE14, Delft, The Netherlands, 17-20 June 2014, www.numge2014.org

2nd International Conference on Vulnerability and Risk Analysis and Management & 6th International Symposium on Uncertainty Modelling and Analysis - Mini-Symposium Simulation-Based Structural Vulnerability Assessment and Risk Quantification in Earthquake Engineering, 13-16 July 2014, Liverpool, United Kingdom, http://www.icvram2014.org

GeoHubei 2014 International Conference Sustainable Civil Infrastructures: Innovative Technologies and Materials, July 20-22, 2014, Hubei, China http://geohubei2014.geoconf.org



ICITG 2014
Second International Conference on Information Technology in Geo-Engineering
21-22 July 2014, Durham, UK
www.icitg.dur.ac.uk

The **2nd International Conference on Information Technology in Geo-Engineering** will be held in Durham, UK on 21-22 July 2014. The conference follows the highly successful first conference held in Shanghai in 2010.

The conference is intended to bring together researchers and practitioners involved in information technology applied to geotechnical engineering, engineering geology and geo-environmental engineering. This is a time of increased activity in research and practice related to information technology and we would like to invite you to attend the conference and participate in the presentations and discussions.

Conference Themes

The broad theme of the conference is information technology applied in any area of geotechnical engineering, engineering geology and geo-environmental engineering. Pa-

pers are solicited under specific sub-themes including but not necessarily limited to the following:

- Geospatial data & Building Information Modelling (BIM)
- Data exchange (including ownership/legal aspects)
- Data standards
- Big Data handling
- Sensors and monitoring
- Artificial Intelligence
- Data mining
- Imaging technologies
- Simulation and Visualisation
- Virtual Reality and Augmented Reality
- Novel numerical techniques

Contacts:

WWW: www.icitg.dur.ac.uk
Email: icitg@durham.ac.uk
Dr Ashraf Osman
Conference Secretary - ICITG 2014
School of Engineering and Computing Sciences
Durham University
Durham, DH1 3LE
United Kingdom
Email: ashraf.osman@durham.ac.uk

Second European Conference on Earthquake Engineering and Seismology, 24-29 August 2014, Istanbul, Turkey www.2eceesistanbul.org

TC204 ISSMGE International Symposium on "Geotechnical Aspects of Underground Construction in Soft Ground" - IS-Seoul 2014, 25-27 August 2014, Seoul, Korea, csyoo@skku.edu

International Symposium on Geomechanics from Micro to Macro (TC105)
01 - 03 September 2014, Cambridge, United Kingdom
ks207@cam.ac.uk

Organizer: TC105
Contact person: Professor Kenichi Soga
University of Cambridge, Department of Engineering, Trumpington Street, CB2 1PZ, Cambridge,, UK
Phone: +44-1223-332713
Fax: +44-1223-339713

JUBILEE CONFERENCE 50th Anniversary of Danube-European Conferences on Geotechnical Engineering Geotechnics of Roads and Railways, 9 - 11 September 2014, Vienna, Austria, www.decge2014.at

IAEG XII CONGRESS Torino 2014 Engineering Geology for Society and Territory, IAEG 50th Anniversary, September 15-19, 2014, Torino, Italy, www.iaeg2014.com

10th International Conference on Geosynthetics – 10ICG, Berlin, Germany, 21 – 25 September 2014 www.10icg-berlin.com

14th International Conference of the International Association for Computer Methods and Advances in Geomechanics (14IACMAG), September 22 – 25, 2014, Kyoto, Japan, www.14iacmag.org

EETC 2014 ATHENS 2nd Eastern European Tunnelling Conference, 28 September - 1 October 2014, Athens, Greece, www.eetc2014athens.org

International Congress Tunnels and Underground Space risks & opportunities, 13-15 October 2014, Lyon, France, www.congres.aftes.asso.fr/en/content/invitation

ARMS 8 - 8th ISRM Rock Mechanics Symposium, 14-16 October 2014, Sapporo, Japan www.rocknet-japan.org/ARMS8/index.htm

9th International Conference on Structural Analysis of Historic Constructions
14 – 17 October 2014, Mexico City, Mexico
www.linkedin.com/groups/SAHC-2014-Mexico-City-3930057.S.213150607

The 9th International Conference on Structural Analysis of Historic Constructions will be held October 14 to 17, 2014, in Mexico City. This conference will take place in English, with English Spanish translation services provided in the main hall. The main topic is "historic constructions are part of our environment and deserve to be saved".

Particular topics will include:

- Conservation of the 20th century architectural heritage
- Adobe and vernacular constructions
- Foundation and geotechnical problems
- Structural assessment and intervention of archaeological sites
- Theory and practice of conservation
- Non-destructive testing, inspection and structural monitoring techniques
- Repair and strengthening techniques
- Analyitcal and numerical approaches
- In-situ and laboratory experimental results
- Innovative and traditional materials
- Seismic behavior and retrofitting

- Rehabilitation, re-use and valorization of cultural heritage buildings
- Case studies

1st International Conference on Discrete Fracture Network Engineering, October 19 - 22, 2014, Vancouver, British Columbia, Canada, www.dfne2014.ca

7th International Congress on Environmental Geotechnics
10-14 November 2014, Melbourne, Australia
www.7iceg2014.com

The International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE), TC 215 Environmental Geotechnics is pleased to announce that the 7th International Congress on Environmental Geotechnics (7ICEG2014) which will be held between the 10-14 November 2014 in Melbourne, Australia.

This Congress is the seventh in a series that started in Edmonton, Canada 1994. It is being organised by Engineers Australia and supported by the Melbourne Convention Bureau (MCB), City of Melbourne and the Australian Geomechanics Society.

Environmental Geotechnics has evolved dramatically from the 80s/90s practice where the focus was on addressing problems related to contaminated sites as well as hazardous and non-hazardous waste management. Nowadays it deals also with emerging contaminants (nanoparticles, etc.), energy geotechnology (geothermal energy, CO2 sequestration, coal seam and shale gas, methane hydrates, etc.), oil and gas resources, mining, reservoir engineering, effect of climate change on built structures and biogeotechnical engineering, attracting new challenges and new set of skills to the profession. These had the effect of bringing the different disciplines even closer than before.

This Congress aims to bring together practitioners and researchers in Environmental Geotechnics and related disciplines to discuss the advances which have been achieved in the past 20 years or so. Since the organisation of the 1st Environmental Geotechnics Congress in Edmonton, Canada in 1994, great progress has been made but we must address the new challenges of a rapidly changing world. In so doing, this Congress will contribute to the ongoing process of consilience between the different disciplines so that current and future challenges are addressed efficiently by our profession.

Regardless of your field in this Industry we are keen to ensure that your interests are responded to in the development of our Congress. The theme is **"Lessons, Learnings and Challenges"**. Our focus is on the intersection of the many factors that promote Environmental Geotechnics around the world.

This Congress will provide opportunities for you to talk with colleagues about your interests and issues in the Industry. Given the Australian context, we encourage a focus on the many sub-themes as outlined below from around the world. We will come together to share achievements and ideas from educators, practitioners, researchers and policy makers. We are keen to ensure that the broad interests of participants are clearly accommodated in the Congress sessions.

Themes

- Planning, legislation and regulatory control
- Containment and management of waste
- Contaminant fate and transport assessment
- Soil, ground vapour and groundwater remediation and redevelopment of derelict land
- Landfill gas management and greenhouse emission abatement
- Energy related geoenvironmental technology
- Waste containment facilities closure and aftercare
- Waste management of disaster affected areas
- Biogeotechnical Engineering
- Developments in geosynthetics for environmental protection

By theming our Congress in this way, we want to promote new conversations that transcend our specific fields and methods of practice through our collective engagement in Environmental Geotechnics.

For further information or assistance, please contact the Congress Office.

7th International Congress on Environmental Geotechnics:

119 Buckhurst Street
South Melbourne VIC 3205 Australia
T +61 3 9645 6311
F +61 3 9645 6322
E 7iceg2014@wsm.com.au
www.waldronsmith.com.au

Innovative Geotechnics for Africa
27 - 30 April 2015, Hammamet, Tunisia

Regional African Conference

Contact person: Mehrez Khemakhem
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Phone: +216 25 956 012
E-mail: mehrez.khemakhem@gmail.com

13th ISRM International Congress on Rock Mechanics
Innovations in Applied and Theoretical Rock Mechanics
10 – 13 May 2015, Montreal, Canada

The Congress of the ISRM "Innovations in Applied and Theoretical Rock Mechanics" will take place on 29 April to 6 May 2015 and will be chaired by Prof. Ferri Hassani.

Contact Person: Prof. Ferri Hassani
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Montreal, QC, Canada H3A 2A7
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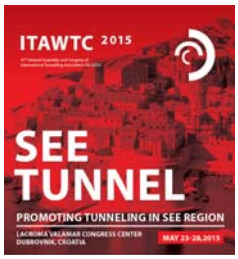

World Tunnel Congress 2015
and 41st ITA General Assembly
Promoting Tunnelling in South East European (SEE) Region
22 - 28 May 2015, Dubrovnik, Croatia
http://wtc15.com

Contact
ITA Croatia - Croatian Association for Tunnels and Underground Structures
Davorin KOLIC, Society President
Trnjanska 140
HR-10 000 Zagreb
Croatia
info@itacroatia.eu

ISFOG 2015 3rd International Symposium on Frontiers in Offshore Geotechnics, Oslo, Norway, 10-12 June 2015, www.isfog2015.no

16th European Conference on Soil Mechanics and Geotechnical Engineering
"Geotechnical Engineering for Infrastructure and Development"
13 - 17 September 2015, Edinburgh, UK
www.xvi-ecsmge-2015.org.uk

The British Geotechnical Association (BGA) is pleased to announce that it will be hosting the 16th European Conference on Soil Mechanics and Geotechnical Engineering at the Edinburgh International Conference Centre from 13th to 17th September 2015. The conference was awarded by a meeting of the European Member Societies on 13th September 2011 at the 15th European Conference on Soil Mechanics and Geotechnical Engineering in Athens, Greece.

You can view the BGA bid document at the following link: http://files.marketingedinburgh.org/bid/ECSMGEELECTRONICBID.pdf

The conference website will be updated regularly as arrangements for the conference progress. Please bookmark it and visit regularly.

We look forward to welcoming you all in Edinburgh, one of Europe's truly great cities, in September 2015.

Dr Mike Winter
Chair of the Organising Committee
mwinter@trl.co.uk

Workshop on Volcanic Rocks & Soils
24 - 25 September 2015, Isle of Ischia, Italy

Volcanic rocks and soils show a peculiar mechanical behaviour at both laboratory and in-situ scale due to their typical structural characters. The Workshop will provide a showcase for researchers to review recent developments and advancements in the geotechnical characterization and engineering applications related with volcanic formations.

The topics will be related to:

- geotechnical characterization under both static and cyclic/dynamic conditions, with special regard to structural properties at different scales;
- geotechnical aspects of natural hazards involving volcanic formations;
- geotechnical problems of engineering structures in volcanic environments.

Organizer: Associazione Geotecnica Italiana (AGI)
Contact person: Ms. Susanna Antonielli
Address: Viale dell'Università 11, 00185, Roma, Italy
Phone: +39 06 4465569 - +39 06 44704349
Fax: +39 06 44361035
E-mail: agi@associazionegeotecnica.it

Website: www.associazionegeotecnica.it

EUROCK 2015
ISRM European Regional Symposium
64th Geomechanics Colloquy
7 – 9 October 2015, Salzburg, Austria

NGM 2016
The Nordic Geotechnical Meeting
25 - 28 May 2016, Reykjavik, Iceland

The aim of the conference is to strengthen the relationships between practicing engineers, researchers, and scientists in the Nordic region within the fields of geotechnics and engineering geology.

All are invited to share their experience and knowledge with their Nordic colleagues.

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Fax: +354 522 1259
E-mail: has@vegagerdin.is

ΕΝΔΙΑΦΕΡΟΝΤΑ ΓΕΩΤΕΧΝΙΚΑ ΝΕΑ

Sinkholes: When the Earth Opens Up

The ground beneath our feet, our cars, our buildings, appears to be incredibly solid. But, rarely, that solid ground can simply open up without warning, dropping whatever was above into an unpredictably deep hole. Sinkholes can be anywhere from a few feet wide and deep, to two thousand feet in diameter and depth. An undiscovered cavern or deep mine can collapse, allowing the ground above to crater, or a broken water main or heavy storm can erode a hole from below, until the surface becomes a thin shell that collapses at once. Communities built atop karst formations are very susceptible, where a layer of bedrock is water-soluble, like limestone, and natural processes can wear away caves and fissures, weakening support of the ground above. Gathered here are images of some of these sinkholes, both man-made and natural, around the world.

A car at the bottom of a sinkhole caused by a broken water line in Toledo, Ohio on July 3, 2013. Police say the driver, 60-year-old Pamela Knox of Toledo, was shaken up and didn't appear hurt but was taken to a hospital as a precaution. Fire officials told a local TV station that a water main break caused the large hole.

A Los Angeles fireman looks under a fire truck stuck in a sinkhole in the Valley Village neighborhood of Los Angeles, on September 8, 2009. Four firefighters escaped injury early Tuesday after their fire engine sunk into a large hole caused by a burst water main in the San Fernando Valley, authorities said.

A man inspects a sinkhole formed in a house on July 19, 2011 in the north of Guatemala City. When neighbors heard a loud boom overnight they thought a gas canister had detonated. Instead they found a deep sinkhole inside a home in a neighborhood just north of Guatemala City. The sinkhole was 12.2 meters (40 feet) deep and 80 centimeters (32 inches) in diameter, an AFP journalist who visited the site reported. Guatemala City, built on volcanic deposits, is especially prone to sinkholes, often blamed on a leaky sewer system or on heavy rain.

A Toledo firefighter rescues Pamela Knox after a massive sinkhole opened up underneath her car in Toledo, Ohio, on July 3, 2013.

On the night of November 11, 1957, a huge hole opened up in Seattle's Ravenna neighborhood, caused by the failure of an underlying six-foot diameter sewer pipe. The 60-foot-deep hole affected only the streets, sidewalks and some yards, as seen in this photo taken at 16th Ave. NE and Ravenna Blvd on November 15, 1957. No homes were damaged, and nobody was injured, but the hole took two years to fill and repair. More on the story **here**. Also, see this intersection today on Google Maps **Street View**.

Aerial view of a huge hole caused after a collapse in the sewage system in the neighborhood of San Antonio, north of Guatemala City, on February 23, 2007. Three people were killed in the collapse, as twelve homes were swallowed up.

In June of 1994, a huge hole, 106 ft. wide by 185 ft. deep, opened in the center of an IMC-Agrico waste stack near Mulberry, Florida. The sinkhole, shown in this July 13, 1994 photo, released 20.8 million pounds of liquid phosphoric acid into the ground below, and into the Floridan aquifer, which provides 90 percent of the state's drinking water. The company voluntarily spent $6.8 million to plug the sinkhole and control the spread of contaminants in the ground water.

A hole remains where a structure once stood in Guatemala City, on February 23, 2007. A giant sinkhole swallowed several homes killing at least three people, officials said.

The Lassing mining disaster. On July 17, 1998 a Talc mine below the town of Lassing, Austria, experienced a partial collapse, filling with groundwater and opening up a sinkhole in the town above. Shortly after, a rescue crew of 10 men went into the mine to search for a single missing miner, and a massive collapse followed, opening up an even larger crater above. The first missing miner was found alive after ten days, but all ten of the rescue team members were killed. Here, workers examine the crater, on July 22, 1998.

Police tape surrounds the house of Jeff Bush, who was consumed by a sinkhole while lying in his bed on the night of April 30, 2013 in Seffner, Florida. First responders were not able to reach Bush after he disappeared and were unable to even recover the body. The house and two neighboring houses were later demolished.

A truck lies in a sinkhole which occurred overnight on Shiliuzhuang road, in Beijing, on April 26, 2011. A section of the road collapsed beneath the truck, slightly injuring the driver and a passenger, who both jumped out the vehicle before it sank into the hole.

A bus, after falling into a pit created by an underground explosion in Rui'an, Zhejiang province, on January 16, 2011. An explosion on a road in east China's Zhejiang Province tossed a bus without passengers four meters into the air, injuring the driver and a 6-year-old boy on the roadside, local fire fighters said on Sunday. The cause of the explosion was under investigation, Xinhua News Agency reported.

People stand next to a 24.9 meter (82 feet) diameter pit at a village in Guangyuan, Sichuan province, on February 28, 2013. According to local media the pit formed on a karst landform last year after the ground surface kept sinking for six days in September. The investigators said the pit may face further sinking after rains due to its geological conditions.

This aerial view shows a large sinkhole that claimed several sports cars, a house, and the deep end of the city swimming pool, in Winter Park, Florida, on May 11, 1981.

Workers use machinery to fill in a sinkhole that buildings collapsed into near a subway construction site in Guangzhou, Guangdong province, China, on January 28, 2013. The hole measured about 1,000 square feet, and was around 30 feet deep, but no one was killed, according to a state media report.

A campsite is sucked underground by the opening of cavernous sinkholes near the Ein Gedi Spa on the shores of the Dead Sea, on September 10, 2008.

A fireman watches a cow being lifted out of a five meter deep hole at Saint Saulve near Valenciennes, northern France, on June 19, 2001. The ground collapsed as two cows crossed over an underground quarry. The cows were unhurt.

Rescuers work at the scene of a landslide in Saint-Jude, Quebec as shown from the air on Tuesday, May 11, 2010. Four people, including two children, are missing after a sinkhole triggered by a landslide swallowed their house northeast of Montreal.

A giant sinkhole in Guatemala City, on May 31, 2010. More than 94,000 were evacuated as the storm buried homes under mud, swept away a highway bridge near Guatemala City and opened up several sinkholes in the capital.

A giant sinkhole caused by the rains of tropical storm Agatha, in Guatemala City, on June 1, 2010. The hole swallowed at least one three-story building.

A large crater that appeared in the early hours in the German town of Schmalkalden, on November 1, 2010.

Neighbors gather near the site of a huge sinkhole in Guatemala City, on May 30, 2010.

A stranded car is hoisted from a collapsed road surface in Guangzhou, Guangdong province, on September 7, 2008.

An aerial view of sinkholes created by the drying of the Dead Sea, near Kibbutz Ein Gedi, Israel, on November 10, 2011.

A man walks past a cement truck which fell into a pit after the road caved in, in Xi'an, Shaanxi province, on September 28, 2012.

Local residents look at a sinkhole near Qingquan primary school in Dachegnqiao town of Ningxiang, Hunan province, on June 15, 2010. The hole, 150 meters (492 feet) wide and 50 meters (164 feet) deep, first appeared in January and has destroyed 20 houses so far.

A local resident throws a stone into a sinkhole near Qingquan primary school in Dachegnqiao town, Hunan province, on June 15, 2010. No causalities had been reported and the reason for the appearance of the hole remains unclear.

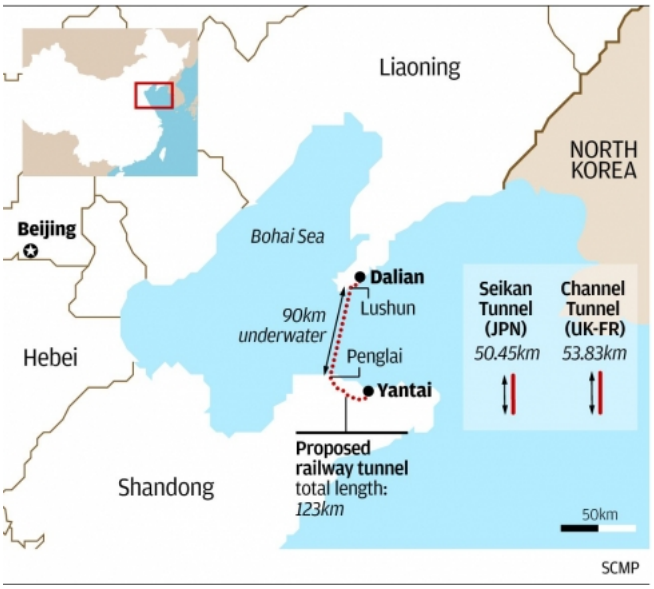
Three homes damaged from a sinkhole sit on the edge of a hill whose lower area collapsed onto other homes in the LaJolla section of San Diego, on October 4, 2007.

(The Atlantic, July 12, 2013, http://world.einnews.com/article/158742686/t8tfbkdJP-lWExuu?afid=777&utm_source=MailingList&utm_medium=email&utm_campaign=Breaking+News%3A+world412-Monday)

Plan to build world's longest undersea tunnel from Dalian to Yantai

The government is planning to spend 260 billion yuan (HK$ 326 billion) to build the world's longest undersea tunnel across the Bohai Strait.

The proposed 123-kilometre railway project would carry passengers and vehicles between the port cities of Dalian in Liaoning's and Yantai in Shandong, according to *Time Weekly*, a Guangdong-based newspaper.



The report said the tunnel, of which 90 kilometres would be under water, would surpass the world's two longest channel tunnels - Japan's Seikan Tunnel and the Channel Tunnel that connects Britain and France.

"It is a key national project that won the full support of Premier Li Keqiang when he was Liaoning's party chief in 2004," said Professor Wang Mengshu, a tunnel and railways expert from the Chinese Academy of Engineering.

Wang said the Bohai Sea tunnel was a critical part of the country's 5,700-kilometre railway project to link the cities of Tongshan in the northeast and Sanya in Hainan.

While the State Council must first review the massive proposal, Wang said work could start as early as 2016 and would take about six years to complete. The China Railway Engineering Corporation would manage the tunnel after it opens.

For security reasons, the structure and design would mirror the 54-kilometre Seikan Tunnel, which is now the world's longest and deepest operational rail tunnel, Wang said.

Passenger vehicles would be loaded onto rail carriages and transported at up to 250km/h, shortening driving time between Dalian and Yantai to an estimated 40 minutes. *Time Weekly* said ferries between the two cities, which are about 170 kilometres apart, require eight hours to make a single trip.

The tunnel proposal includes 12 comprehensive studies compiled by more than 100 experts over more than two decades. It could be submitted to the State Council with an endorsement from the academy as soon as next month, Wang said.

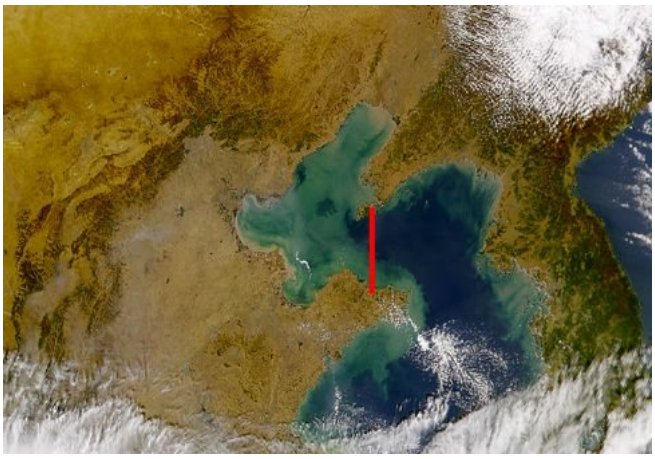
Time Weekly said the Liaoning and Shandong governments were asked to provide 100 billion yuan each, while the other 60 billion yuan would be covered by railway corporation.

The investment of 260 billion yuan was projected to break even within 12 years. Daily traffic flow between Dalian and Yantai was expected to increase to more than 100,000 vehicles by 2015.

(Minnie Chan / South China Morning Post, 12 July, 2013, http://www.scmp.com/news/china/article/1280386/china-plans-worlds-longest-undersea-tunnel)

Το σχέδιο αναβιώνει

Τη μεγαλύτερη υποθαλάσσια σήραγγα του κόσμου θέλει να κατασκευάσει η Κίνα



Η σήραγγα (κόκκινο) θα συνέδεε τα άκρα του κόλπου του Μποχάι, ο οποίος αντιστοιχεί στο εσώτερο τμήμα της Κίτρινης Θάλασσας (Προσαρμογή από NASA Goddard Spaceflight Center)

Η Κίνα θα επενδύσει 260 δισεκατομμύρια γουάν, ή περίπου 32 δισεκατομμύρια ευρώ, για την αναβίωση ενός παλιού σχεδίου αφορά την κατασκευή της μεγαλύτερης υποθαλάσσιας σήραγγας στον κόσμο. Το τούνελ στα Στενά του Μποχάι, μήκους 123 χιλιομέτρων, θα συνέδεε τις ανατολικές με τις βορειοανατολικές περιοχές της χώρας, μειώνοντας την απόσταση κατά σχεδόν 1.000 χλμ.

Η σήραγγα θα ξεκινάει από το λιμάνι της πόλης Νταλιάν στην βορειοανατολική επαρχία Λιαονίνγκ και θα καταλήγει στην πόλη Γιαντάι στην ανατολική Σαντόνγκ, αναφέρει ο δικτυακός τόπος China Economic Net.

Πάντως το δημοσίευμα δεν διευκρινίζει πότε θα ξεκινήσει το έργο και πότε θα ολοκληρωθεί.

Η Κίνα είχε ανακοινώσει για πρώτη φορά το σχέδιο το 1994, εκτιμώντας ότι η σήραγγα θα είχε ολοκληρωθεί έως το 2010 με κόστος κόστος 10 δισ. δολάρια. Είκοσι χρόνια αργότερα, το φιλόδοξο παραμένει στο στάδιο του σχεδιασμού, αναφέρει ο δικτυακός τόπος χωρίς να δίνει λεπτομέρειες.

Το κόστος για την κατασκευή της σήραγγας θα μπορούσε να αποσβεστεί σε διάστημα 12 ετών, δήλωσε ο Ουάνγκ Μενγκσού, μέλος της Κινεζικής Ακαδημίας Μηχανικών, ο οποίος εκτίμησε ότι τα ετήσια έσοδα από την λειτουργία της σήραγγας θα ανέρχονται σε περίπου 20 δισεκατομμύρια γουάν.

Η μεγαλύτερη υποθαλάσσια σήραγγα του κόσμου βρίσκεται στην Ιαπωνία -η σήραγγα Σεϊκάν, μήκους 54 χιλιομέτρων, συνδέει τις νήσους Χονσού και Χοκάιντο και παραδόθηκε το 1988 ύστερα από δύο δεκαετίες κατασκευής.

Ξεπερνά κατά τρία περίπου χιλιόμετρα τη σήραγγα της Μάγχης, η οποία συνδέει την Αγγλία με τη Γαλλία και έχει μήκος περίπου 51 χιλιομέτρων.

(Newsroom ΔΟΛ, με πληροφορίες από ΑΠΕ/Reuters, 11 Ιουλίου 2013, http://news.in.gr/science-technology/article/?aid=1231257056)

Να τους καλέσουμε για συμβούλους ...

Πήραν την κατάσταση στα ... πόδια τους

Κάστορες σώζουν ρωσικό χωριό από την έλλειψη νερού

Αψηφώντας το μέγεθος του έργου, κάστορες που ζουν κοντά σε ένα απομακρυσμένο ρωσικό χωριό ανέλαβαν να χτίσουν ένα τεχνητό φράγμα, δίνοντας λύση στο επιτακτικό πρόβλημα έλλειψης νερού που αντιμετώπιζαν οι κάτοικοι.

Επί τουλάχιστον μία δεκαετία, οι κάτοικοι του ρωσικού χωριού Μπόμπροφκα, κοντά στα Ουράλια, κάνουν μάταια αιτήσεις στην τοπική αυτοδιοίκηση για κατασκευή ενός νέου

φράγματος, καθώς το παλαιό, φτιαγμένο επί σοβιετικής εποχής, καταστράφηκε.

Η έλλειψη ταμιευτήρα, σε απόσταση τουλάχιστον 30 χλμ. από την κοντινότερη πόλη στη Σιβηρία, δημιουργεί σειρά προβλημάτων: από ανεπάρκεια ποτιστικού νερού, έως ανυπαρξία αποθηκευμένου νερού για έκτακτες καταστάσεις, όπως μία πυρκαγιά.

Τη λύση ανέλαβε οικειοθελώς να δώσει μία ομάδα αποφασισμένων καστόρων, η οποία άρχισε να χτίζει νυχθημερόν ένα φράγμα, εντυπωσιάζοντας μάλιστα με την ποιότητα της εργασίας της. «Εάν οι άνθρωποι δεν το ρίξουν, αυτό το φράγμα θα στέκεται εδώ για πάντα», δήλωσε ένας κάτοικος, όπως μετέδωσε το Sky News.

(Newsroom ΔΟΛ / 16 Ιουλίου 2013, http://news.in.gr/perierga/article/?aid=1231257784)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΣΕΙΣΜΟΙ

Αιώνιοι γίγαντες
Αντιμέτωπα με τη διάβρωση, τα ψηλά βουνά κρατούν το ανάστημά τους

Η κορυφή του Έβερεστ θα παραμείνει για καιρό πάνω από τα σύννεφα

Πώς τα όρη κατορθώνουν να ζουν... σαν τα ψηλά βουνά και να μένουν όρθια για εκατοντάδες εκατομμύρια χρόνια ενώ κανονικά θα έπρεπε να «τρώγονται» από τη διάβρωση και κάποια στιγμή να εξαφανίζονται; Μια μελέτη δίνει για πρώτη φορά μια απάντηση, η οποία εκτός από ικανοποιητική είναι και απρόσμενη. Το μοντέλο που προτείνει δείχνει ότι οι ίδιες οι δυνάμεις της διάβρωσης είναι αυτές που χαρίζουν στις οροσειρές της Γης τη μακροζωία τους.

Ο,τι ανεβαίνει κατεβαίνει

Σύμφωνα με τις κρατούσες θεωρίες τα βουνά, τα οποία υψώνονται όταν οι τεκτονικές πλάκες συναντιούνται μεταξύ τους σπρώχνοντας προς τα επάνω τον φλοιό της Γης, θα πρέπει με την πάροδο του χρόνου να «κονταίνουν», υποκύπτοντας στη διάβρωση που υφίστανται εξωτερικά, από παράγοντες όπως η βροχή, οι παγετώνες και οι κατολισθήσεις, αλλά και εκ των έσω, από τους ποταμούς που διαβρώνουν το μητρικό πέτρωμα στη βάση τους. Λαμβάνοντας υπόψη όλους αυτούς τους διαβρωτικούς παράγοντες, τα υπάρχοντα μοντέλα δίνουν στις οροσειρές περιορισμένο χρόνο ζωής: ένα όρος ύψους 4.000 μ. για παράδειγμα θα πρέπει να χάνει το μισό ύψος του μέσα σε 20 εκατομμύρια χρόνια. Παρ' όλα αυτά πολλές οροσειρές της Γης, από τα Απαλλάχια στις Ηνωμένες Πολιτείες ως τα Ουράλια στη Ρωσία, στέκονται σταθερά στο ύψος τους εδώ και εκατοντάδες εκατομμύρια χρόνια.

Τώρα μια μελέτη που δημοσιεύθηκε στην επιθεώρηση «Nature» δίνει μια απάντηση σε αυτό το παράδοξο. Το μυστικό, όπως υποστηρίζουν οι ερευνητές από το Πανεπιστήμιο του Όρχους στη Δανία με επικεφαλής τον Ντέιβιντ Εγκχολμ, βρίσκεται στην αλληλεπίδραση των μηχανισμών της διάβρωσης. Αντί να συνεργούν για να «κοντύνουν» τα βουνά, όπως υποστηρίζει η κρατούσα θεωρία, κατά κάποιον τρόπο αλληλοεξουδετερώνονται επιβραδύνοντας σημαντικά τη διαβρωτική διαδικασία.

Φρένο στον φαύλο κύκλο

Ως τώρα οι ειδικοί θεωρούσαν ότι ο κύριος διαβρωτικός παράγοντας για τα όρη είναι οι ποταμοί, οι οποίοι «τρώνε» σιγά-σιγά το μητρικό πέτρωμα στο εσωτερικό των βουνών αν τα νερά τους μεταφέρουν μεγάλες ποσότητες λειαντικής άμμου και άλλων σωματιδίων. Όταν τα βουνά «σπρώχνονται» προς τα πάνω από την κίνηση των τεκτονικών πλακών, πρεσβεύει η υπάρχουσα θεωρία, οι «νεόκοπες» πλαγιές τους είναι σε μεγάλο βαθμό απότομες, με αποτέλεσμα να υφίστανται συχνές κατολισθήσεις. Οι κατολισθήσεις αυτές διοχετεύουν περισσότερα διαβρωτικά υλικά στους ποταμούς, οι οποίοι με τη σειρά τους πυροδοτούν νέες κατολισθήσεις σε έναν φαύλο κύκλο που, με την πάροδο των χιλιετιών, «τρώει» σιγά-σιγά τις οροσειρές.

Προσομοιώνοντας ωστόσο τη διαδικασία εξέλιξης των βουνών αμέσως μετά την ανύψωσή τους από την κίνηση των τεκτονικών πλακών, οι επιστήμονες από τη Δανία ανακάλυψαν ότι τα πράγματα μάλλον δεν εξελίσσονται ακριβώς κατ' αυτόν τον τρόπο. Διαπίστωσαν ότι οι πλαγιές των οροσειρών καθώς διαβρώνονται αρχίζουν σιγά-σιγά να γίνονται πιο ομαλές και πιο σταθερές - η ροπή τους προς τις κατολισθήσεις μειώνεται. Μαζί με αυτήν μειώνεται και η εισροή λειαντικών στοιχείων στους ποταμούς, και άρα και η διαβρωτική τους δράση. Έτσι, καθώς οι δύο σημαντικότεροι παράγοντές της μπαίνουν σε «ύφεση», η διάβρωση σε μεγάλο βαθμό «φρενάρει». Σύμφωνα με αυτό το μοντέλο ο χρόνος ζωής των ψηλών βουνών ξεπερνά τα 200 εκατομμύρια χρόνια - διάστημα πολύ πιο κοντινό στην ηλικία των μεγάλων οροσειρών του πλανήτη.

(Βήμα Science / Newsroom ΔΟΛ, 07 Ιουλ. 2013, http://news.in.gr/science-technology/article/?aid=1231256325)

Predicting earthquakes and saving lives - with smartphones

In 1989, the strongest quake since 1906 hit San Francisco, killing 63 and injuring more than 3,500

Living in an earthquake zone adds a certain spice to life.

To the normal catastrophes of day-to-day existence, you can add the possibility that the earth will open up underneath you and swallow you whole.

The first earthquake is scary - but unless a massive shaker comes along you quickly become accustomed, even complacent.

This is when being prepared becomes even more important; your survival kit with plenty of bottled water, knowing where - and where not - to shelter.

And actually scrambling into these areas at 5 am when a quake hits, instead of rolling over, going back to sleep and assuming it's not the "big one" because you had a late night and don't want to crawl out of bed.

This is where being alerted to the fact this isn't just a tummy trembler, it's actually a potentially devastating magnitude 7.5 would be useful - because it could save your life.

Unfortunately, early warning systems are hugely expensive pieces of infrastructure to build from scratch.

So a team from the California Institute of Technology (Caltech) has created an app that uses the accelerometer in your smartphone, and turns it into a simple seismometer (device that detects the vibrations from earthquakes).

Group dynamics

Richard Guy has managed the Community Seismic Network for the last two and a half years

Richard Guy is part of the team that put together CrowdShake, with graduate computer science student Matt Faulkner.

He manages Caltech's Community Seismic Network, which has been running an earthquake monitoring project for the past three and a half years, to complement the more formal seismic monitoring services.

"In the Pasadena area, which is a relatively small community - it's hardly 10km across - we have hundreds and hundreds of volunteers that we give a very small low-cost accelerometer to, it's actually a seismometer," he says.

The devices either plug into a PC or router, and pick up the vibrations caused by tremors.

Earthquake early warning systems rely on lots of sensors spread over a region. So when an earthquake begins, the closest stations pick up the tremors.

The data they gather is then sent to processing centres, where the intensity is calculated, and the time it will take for the quake to reach other areas. Then alerts are sent out. This system, although more basic, works on the same principles.

Be prepared: As a coastal state, tsunamis are also a danger in California, as this sign on Venice Beach points out

The project has hit a few bumps in the road - there's the cost of the devices, and the fact that some are simply never installed.

So the next logical step was a Smartphone app called Crowd Shake - meaning no hardware to buy or maintain.

"The attractiveness of smart phones is that they have many things already built in," says Mr Guy.

"The accelerometer is already in the phone, the location is something the phone knows, it's not something that a person has to tell it.

"And of course your Smartphone knows exactly what time it is."

This seismometer plugs into your home router. The lid is removed to reveal the hardware

They are also easy to use, says Mr Guy.

"From that point of view smart phones are an extraordinarily attractive device for monitoring earthquakes.

"Now on the other hand, they come with very interesting challenges - the sensor, the accelerometer in a Smartphone is certainly not of the quality of any sort of a device you would add to your PC or some other setting. So that's a basic challenge."

Distinguishing normal movement from the vibrations from an earthquake is also tricky.

"If there are just enough [phones] that are stationary, which could be a very small percentage, from that we can determine, 'OK, an earthquake is under way and this is how intense it was at a certain point'," he says.

The data is analysed and then pushed back to the community of users.

"Then the receiving phone says, 'Well, I know where I am, I know where it started, I know the time difference between when the event began, I know what time it is now, my little

phone app can calculate very, very simply in just a few millesions, this is how bad I think it's going to be where I am right now.'

"It can then provide... an alert to this user saying: 'You have so many seconds before a damaging wave will arerive'."

At the moment the app is still a prototype. Implementation across California is unlikely unless it is done by government agencies, as the risk of litigation is so high - for example, should someone be injured during a false alarm, says Mr Guy.

So the target is the developing world - countries with a high risk of earthquake, but without an early warning infrastructure in place - where mobile ownership is common.

Buhl, in western India, suffered a devastating earthquake in 2001. The region is being considered as a tested for Crowd Shake

Early bird

The big brother to the Community Seismic Network project is the California Integrated Seismic Network's Earthquake Early Warning System.

"The network of seismometers is really a computer network," says the director of Caltech's Earthquake Engineering Research Laboratory, Tom Heaton.

"We basically monitor all of the shaking that happens at roughly about 400 stations in the western United States, and we have access to that information within about a secnod of when the shaking occurs at the station."

When a quake is detected members of the network are alerted.

"We've been writing software that does the kind of analysis a human being would do if they had time to do it," he says.

"The one that I work on is called the virtual seismologist, we're trying to teach a computer to be like a seismologist, but unlike a seismologist, computers can stay awake all the time and they don't get bored."

The early warning system has already been proven to work. At Caltech they're working on ways to send alerts to smart devices, which inevitably includes a Smartphone app.

"The app gets notification that an earthquake has occurred .... It can project when the shaking will get to the phone and how big it will be. And then the phone can start to countdown and say, shaking in 10, 9, 8, and even give some idea - strong shaking or weak shaking depending on what we anticipate."

One of the big hold-ups is financing. The project has received funding from the US Geological Survey (USES) and more recently the Gordon and Betty Moore Foundation, while waiting to find out whether a bill currently in front of the state legislature will implement the system.

Sims city: The early warning system was used during an earthquake drill held in Los Angeles in March

Proof that this type of technology works can be found in Japan.

The country has an effective early warning system administered by the Japan Meteorological Agency. Thanks to apps like Yorker Call, earthquake alerts can be pushed to smartphones, while the iPhone 5 can do it automatically.

No matter how sophisticated these systems are, there's only so much a warning can do.

In March 2011, the north-east of Japan experienced the most powerful earthquake to hit the country, a magnitude of 9.0. This was followed by a tsunami that inundated the Pacific coast.

In Japan it is called the Great East Japan Earthquake. It is thought that close to 20,000 people were killed.

Carp streamers - or koinoburi - are hung outside Japanese homes with sons on Children's Day on 5 May. But this school of 370 blue carp mourn the children who died in Higashimatsushima, Miyagi prefecture

The early warning system certainly saved lives. But the scale of the disaster was just too big. And the tsunami alert, which takes longer to compute and generate, gave some only 15 minutes to get to higher ground.

The American Red Cross has launched a suite of apps created by UK-based developers 3 Sided Cube for use in natural disasters, one of which is for earthquakes.

It uses the USGS feed giving information on quakes as they happen, and sends alerts to people who have set the app to watch certain areas. It then sends them to a page with more information.

"[We] developed this app to give instant access to information on what to do before, during and after earthquakes with preparedness information developed by trusted Red

Cross experts," says the American Red Cross's Matt Goldfeder.

The American Red Cross app gives details of shelters

"The app also includes preparedness information for events that may happen after earthquakes, such as fires and tsunamis."

An "I'm safe" button lets you send an alert to family, friends and social networks, where you can also share information. It includes a toolkit that has a torch setting, strobe light and an alarm.

"A recent Red Cross survey shows that nearly one-fifth of Americans say they've received some kind of emergency information from an app they've downloaded. It's important that people can access this information right on their mobile device," says Mr Goldfeder.

Other apps that claim to help in the aftermath include Earthquake Buddy, which will send an alert to four contacts if a phone detects an earthquake, with your GPS co-ordinates attached. For Californians, MyFault shows areas likely to be subject to landslide or liquefaction.

And apps like QuakeFeed and QuakeWatch let you track earthquakes around the world as they happen.

Technology might not be able to save the world. But it might be able give you and your loved ones the edge when it comes to surviving the worst of natural disasters.

(Fiona Graham, Technology of business reporter / BBC News, 9 July 2013, http://www.bbc.co.uk/news/business-23204346)

NASA says new technology could help buildings survive earthquakes (video)

NASA engineers say they've found a new way to keep structures from shaking that could help buildings survive earthquake damage. The technology was developed at Marshall Space Flight Center and successfully tried out on the 365-foot-tall Dynamic Test Stand that has also tested the Saturn V rocket and the space shuttle.

"Not only could this technology be applied to existing structures that have problems ... it could change the way buildings and other structures are designed," project manager Rob Berry said in a NASA news release. "It could have the ability to keep aircraft, ships and oil platforms steady during high winds, waves and other weather events – anywhere where fluids and structures coexist. We are currently in discussion with industry regarding potential applications."

The patented technology, called fluid structure coupling, had its origin in NASA's attempt to mute the dangerous vibration in launch vehicles with huge liquid fuel tanks. Engineers designed a device to fit inside a fuel tank to calm the vibrations during liftoff.

The massive 365-foot-tall Dynamic Test Stand at Marshall Space Flight Center that NASA engineers first shook, then quieted with a new fluid stabilization device. (NASA)

To test their device, engineers went to the 4.5 million-pound building. They put a 14,000 pound water tank and large weights on the top floor and moved the weights back and forth to make the entire building sway. But when they turned on the new device inside the tank, NASA says, "the movement was nearly completely stopped."

The device, which weighs less than 100 pounds, "controls the interaction between the fluid and the structure," Berry said. In the test, the results were equivalent to reducing the vibration of a 650,000 pound launch vehicle.

(Lee Roop / All Alabama, July 12, 2013, http://blog.al.com/breaking/2013/07/nasa_says_new_technology_could.html)

Περιστροφικός ίλιγγος

Η διάρκεια του 24ωρου αλλάζει από το λόξυγκα της Γης

Αν νομίζετε ότι η κάθε μέρα της ζωής σας έχει ακριβώς 24 ώρες, πλανάστε πλάνην οικτρά. Όπως είναι γνωστό στους επιστήμονες, η διάρκεια της ημέρας αλλάζει ανά περιόδους εξ αιτίας μεταβολών στην περιστροφή της Γης. Τώρα μια μελέτη «μετράει» για πρώτη φορά κάθε πότε ακριβώς συμβαί-

νει αυτό, εντοπίζοντας μάλιστα έναν «έξτρα», άγνωστο ως τώρα παράγοντα που «παίζει» με το εικοσιτετράωρό μας και φαίνεται να συνδέεται με το μαγνητικό πεδίο της Γης.

Μεταβολές στην περιστροφή της Γης αφαιρούν ή προσθέτουν χιλιοστά του δευτερολέπτου στο εικοσιτετράωρό μας

Η περιστροφή της Γης παρουσιάζει διακυμάνσεις κάθε χρόνο ή ανά δεκαετία εξαιτίας μεταβολών που σημειώνονται στην ατμόσφαιρα και στους ωκεανούς της αλλά και στο εσωτερικό της, στον μανδύα και τον πυρήνα της. Ωστόσο οι ακριβείς μεταβολές που προκαλούν οι διακυμάνσεις αυτές στη διάρκεια της ημέρας και τα «μοτίβα» που ακολουθούν δεν ήταν πλήρως γνωστά στους επιστήμονες. Μια ομάδα ερευνητών με επικεφαλής τον Ρίτσαρντ Χολμ του Πανεπιστημίου του Λίβερπουλ της Βρετανίας ανέλυσε αστρονομικά και δορυφορικά δεδομένα από το 1969 ως σήμερα με στόχο να τις καταγράψει.

Στη μελέτη τους, που δημοσιεύθηκε στην επιθεώρηση «Nature», παρουσιάζουν τη σαφέστερη «απεικόνιση» της διάρκειας του εικοσιτετραώρου μας για τα τελευταία πενήντα χρόνια. Οι ερευνητές εντόπισαν τρεις διαφορετικούς παράγοντες που προκαλούν «λόξυγκα» στην κίνηση της Γης καθώς αυτή γυρίζει γύρω από τον εαυτό της – και αυξομειώνουν σε διαφορετικό βαθμό τη διάρκεια της μέρας μας σε τρεις διαφορετικούς κύκλους.

Επιρροές από τα «σπλάχνα» του πλανήτη

Κατ' αρχάς κατέγραψαν λεπτομερώς μια γνωστή διακύμανση, κατά την οποία η διάρκεια της ημέρας αυξάνεται ή μειώνεται ανά περίπου μια δεκαετία κατά μερικά χιλιοστά του δευτερολέπτου για να επανέλθει μετά στα «φυσιολογικά» της επίπεδα. Η διακύμανση αυτή οφείλεται σε βραδείες μεταβολές που σημειώνονται στον πυρήνα της Γης.

Ο δεύτερος κύκλος που καταγράφηκε οφείλεται επίσης σε διεργασίες που σημειώνονται στο εσωτερικό του πλανήτη, και συγκεκριμένα στους συνεχείς κλυδωνισμούς που παρατηρούνται από την αλληλεπίδραση του ρευστού πυρήνα και του στερεού μανδύα του, και ως τώρα δεν ήταν πολύ γνωστός στους ειδικούς. Όπως αποδείχθηκε, ο κύκλος αυτός διαρκεί 5,9 έτη και αλλάζει τη διάρκεια της ημέρας κατά κλάσματα του χιλιοστού του δευτερολέπτου κάθε χρόνο.

Μαγνητική αναπήδηση

Οι ερευνητές κατέγραψαν όμως και μια τρίτη κατηγορία μεταβολών, η οποία ως τώρα δεν είχε παρατηρηθεί. Είδαν ότι τρεις φορές μέσα στα τελευταία χρόνια, και συγκεκριμένα το 2003, το 2004 και το 2007, η περιστροφή του πλανήτη παρουσίασε μικρές «αναπηδήσεις». Οι αναπηδήσεις αυτές παρεμβάλλονται αλλάζοντας τις πιο μακροπρόθεσμες μεταβολές κατά ένα κλάσμα του χιλιοστού του δευτερολέπτου και διαρκούν για μερικούς μήνες προτού τα πράγματα επανέλθουν στη φυσιολογική τους κατάσταση.

Ελέγχοντας δορυφορικές δεδομένα σχετικά με το μαγνητικό πεδίο της Γης την τελευταία 20ετία οι επιστήμονες είδαν ότι ανάλογες αναπηδήσεις, οι οποίες συμπίπτουν με αυτές της περιστροφής, σημειώνονται και στο μαγνητικό πεδίο του πλανήτη. Ο κ. Χολμ υποπτεύεται ότι αυτές οι ξαφνικές μεταβολές ενδεχομένως προκαλούνται όταν ένα κομμάτι λιωμένου πυρήνα προσκολλάται προσωρινά στον μανδύα, αλλάζοντας τη γωνιακή ταχύτητα της Γης.

(Βήμα Science / Newsroom ΔΟΛ, 12 Ιουλίου 2013, http://www.tovima.gr/science/technology-planet/article/?aid=521938&h5=true)

Characterization and implications of intradecadal variations in length of day

R. Holme & O. de Viron

Variations in Earth's rotation (defined in terms of length of day) arise from external tidal torques, or from an exchange of angular momentum between the solid Earth and its fluid components[1]. On short timescales (annual or shorter) the non-tidal component is dominated by the atmosphere, with small contributions from the ocean and hydrological system. On decadal timescales, the dominant contribution is from angular momentum exchange between the solid mantle and fluid outer core. Intradecadal periods have been less clear and have been characterized by signals with a wide range of periods and varying amplitudes, including a peak at about 6 years. Here, by working in the time domain rather than the frequency domain, we show a clear partition of the non-atmospheric component into only three components: a decadally varying trend, a 5.9-year period oscillation, and jumps at times contemporaneous with geomagnetic jerks. The nature of the jumps in length of day leads to a fundamental change in what class of phenomena may give rise to the jerks, and provides a strong constraint on electrical conductivity of the lower mantle, which can in turn constrain its structure and composition.

(*Nature* **499**, 202–204, 11 July 2013, http://www.nature.com/nature/journal/v499/n7457/full/nature12282.html)

Τα ηφαίστεια «ουρλιάζουν»!
Παράγουν θορύβους από γεωλογικές διεργασίες που σημειώνονται πριν από μια έκρηξη

Όπως φαίνεται κάποια ηφαίστεια προειδοποιούν με κραυγές ότι πρόκειται να εκραγούν

Αμερικανοί ερευνητές διαπίστωσαν ότι ορισμένα ηφαίστεια «ουρλιάζουν» πριν εκδηλωθεί μια έκρηξη σε αυτά. Σύμφωνα με τους ερευνητές το «ουρλιαχτό» είναι προϊόν μικρών σεισμικών δονήσεων που προηγούνται των εκρήξεων. Ίσως λοιπόν η παρακολούθηση της σεισμικής δραστηριότητας σε περιοχές όπου υπάρχουν ενεργά ηφαίστεια να βοηθήσει στην έγκαιρη πρόβλεψη μιας έκρηξης.

Τα ηχηρά «τρέμουλα»

Επιστήμονες του Πανεπιστημίου της Ουάσινγκτον μελέτησαν την ακολουθία των εκρήξεων στο ηφαίστειο Redoubt στην Αλάσκα. Διαπίστωσαν ότι κάθε φορά που εκδηλωνόταν κάποια σεισμική δραστηριότητα παράγονταν ήχοι που έμοιαζαν με «ουρλιαχτά». Οι ερευνητές θεωρούν ότι οι ήχοι παράγονται όταν η σεισμική δραστηριότητα από σταθερούς παλμούς αρχίζει να μετατρέπεται σε γρήγορους κραδασμούς.

Πιστεύουν ότι η παρακολούθηση της σεισμικής δραστηριότητας γύρω από ηφαίστεια μπορεί να αποτελέσει ένα δείκτη πρόβλεψης ηφαιστειακών εκρήξεων. Η μελέτη δημοσιεύεται στην επιθεώρηση «Journal of Volcanology and Geothermal Research».

(Βήμα Science / Newsroom ΔΟΛ, 17 Ιουλίου 2013, http://www.tovima.gr/science/technology-planet/article/?aid=522683&h5=true)

Natural Disasters at All-Time High in China

Earthquakes taking a commanding lead in causing damage and economic losses

The number of natural disasters occurring in China has been significantly high this year, with earthquakes occurring much more frequently than anticipated.

China's average annual number of earthquakes between M5.0 (magnitude 5 on the Richter Scale) and M5.9 has usually been approximately 20, between M6.0 and M6.9 has occured on average 3 to 4 times, and two occurrences of M7.0 or larger may occur every two to three years, according to the China Earthquake Networks Center (CENC).

However, in recent years, frequent earthquakes of unexpectedly large magnitudes have occurred in China.

A resident cries on her collapsed house in Hetuo Township in Dingxi, northwest China's Gansu province on July 22, 2013. Double tremors killed 73 people and injured almost 600, officials said. (STR/AFP/Getty Images)

China's Ministry of Civil Affairs stated in a report that earthquakes ranging between M5.0 and M8.0 have occurred 21 times in the first six months of 2013, which is much higher than the annual earthquake predictions of the CENC.

Earthquakes Most Damaging

Despite the increasing number of all types of natural disasters, earthquakes are considered to be the most damaging and to cause the highest economic losses.

Earthquakes caused more damage to the country than any other severe weather disasters—drought, floods, snowstorms, hail, landslides, sandstorms, prairie fire, storms, and typhoons struck the country from January to June. But, 32 percent of house collapses and 53 percent of houses damaged are primarily due to devastating quakes, the Ministry of Civil Affairs report said.

Six M5.0+ earthquakes were recorded in Sichuan alone during the six months, with the tremor damages accounting for 80 percent of the nation's total earthquake-related economic losses, according to a July report by China Meteorological Administration (CMA).

The biggest Sichuan earthquake during the period, occurring on April 20, 2013, was M7.0 and killed more than 196 people, injured 13,484, and affected 2.31 million, according to official statistics.

The economic losses in Sichuan's three hardest-hit counties Lushan, Baoxing, and Tianquan were estimated at 61 billion yuan (approximately US$10 billion), with insured losses of 6.1 billion yuan (approximately US$100 million).

The April Global Catastrophe Recap report by Impact Forecasting, the catastrophe model development center at the world's leading reinsurance broker, Aon Benfield, estimated a local insurance penetration of 1 percent.

Yet, these three counties claimed the total economic losses had been estimated at 169 billion yuan (approximately US$27 billion). According to the 21st Century Business Herald, this amount is 21 times more than the counties' combined gross domestic product (GDP) of 2012.

Earthquake Warnings Ignored

Three days before an M5.2 earthquake rattled Southwest China's Yunnan Province on April 17, 2013 causing at least 10 injuries and damaging more than 16,109 homes and other buildings, a man had predicted the possibility of a M5.0 earthquake in Yunnan's Dali Bai Autonomous Prefecture and posted his warning blog on Sino Weibo—China's Twitter-like microblogging site.

After the Yunnan quake, the blogger said his prediction was made by analyzing the data obtained from the Yunnan Earthquake Administration's official website. In response, the provincial administration claimed it is illegal to publicly release information submitted by individuals or private sectors regarding any anticipated future earthquake.

The Chinese Communist Party (CCP) leaders have been ignoring such warnings for more than 30 years.

For example, three seismological monitoring organizations warned Chinese authorities of the impending Tangshan earthquake 30 years ago. Majiahe Seismic Center at Kailuan Mine, Beijing City Seismic Bureau, and Tangshan City Seismic Office reported seismological changes to the National Seismological Bureau and urged it to take preventive measures to reduce potential damage. But authorities ignored the warnings and deliberately withheld the information for the sake of political stability.

(Li Ping - Translated by Euly Luo. Written in English by Arleen Richards / EPOCH TIMES, July 23, 2013, http://world.einnews.com/article/159958679/dK8XRioZF7c1l6Bu?afid=777&utm_source=MailingList&utm_medium=email&utm_campaign=Breaking+News%3A+world420-Tuesday. Read the *original Chinese article*.)

John Milne: Isle of Wight's earthquake science pioneer

An iron lamp-post on the Isle of Wight played an unlikely part in teaching the world about the nature of earthquakes.

It was part of a homemade seismograph designed by a Victorian scientist to pick up signs of tiny ground tremors.

Despite John Milne's pioneering experiments causing quite a stir on the island, where some locals mistook his instruments for ghostly activity, his name is now little known outside scientific circles.

John Milne (centre) with Russian seismologist Prince Boris Galitzin and his wife Tone Harikaw

He is however, revered in Japan where he laid the foundations for how the country copes with the ever-present danger of earthquakes.

Milne's great nephew has produced a film on his achievements, part of a series of commemorative events on the island marking 100 years since his death.

Dr William Twycross, a GP in Australia, said his family was always aware of their illustrious forbear, who became known as the "father of seismology".

While producing The Man Who Mapped the Shaking Earth, Dr Twycross travelled to some of the earthquake zones his great uncle had visited, including San Francisco, Iceland and Japan.

"It was very exciting, we learnt a lot more about his life. He was a remarkable man and a great traveller," he said.

Island life

Milne moved to the Isle of Wight in 1895 with his Japanese wife. From his observatory at Blackwater Road in Shide, he collated and analysed earthquake information sent from around the world.

Based on his studies of tremor data he plotted the Pacific fault line known as the "Ring of Fire".

The Isle of Wight Society's biography recalls how Milne became a familiar figure around the island. He acquired a full size lamp-post from a local ironmongers to make a horizontal seismograph which could detect tiny tremors.

Many scientists and dignitaries from around the world called at his home, including the then Prince of Wales.

For some islanders however, the science was something of a mystery.

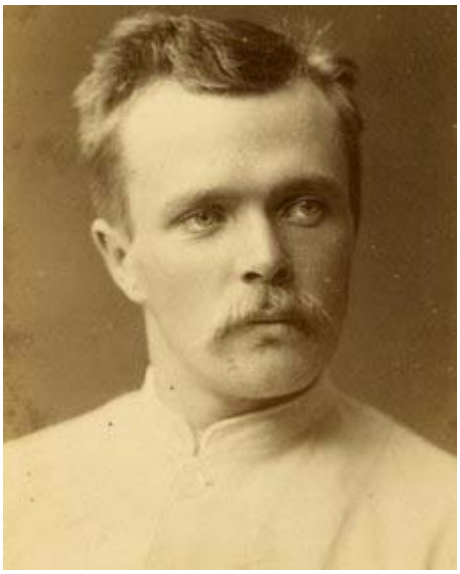
Slight movements in his instruments' lights at night was enough to convince drinkers at the Barley Mow pub that the Isle of Wight was tipping up and down. Others thought it was the sign of ghosts in the fields.

Another piece of monitoring equipment installed at a sailing club showed increased readings at the same time each evening - which was eventually put down to a regular liaison between a butler and a chambermaid in an adjoining room.

While working in Japan from the 1870s, Milne built what is believed to be the world's first seismograph and identified the fault line on which, more than a century later, the epicentre of the devastating earthquake of 2011 lay.

He also produced the first guidelines for civil engineers constructing buildings in earthquake-prone regions which Dr Twycross said "saved millions of lives".

The Japanese emperor conferred on him the honour of the Third Order of the Rising Sun for his contribution to the understanding of the quakes and he was given the title of emeritus professor of seismology at Tokyo University.



John Milne produced guidelines for building in earthquake zones

Dr Twycross accepts Milne will always be more famous in Japan than in his native country.

"It's bound to happen - earthquakes are an important part of the history of Japan, more so than in Britain which is not as prone," he said.

"At the time it was meeting of Victorian technology and the need to discover what was going on in the earth."

Among events to honour Milne on the centenary of his death are a church service and a premiere screening of Dr Twycross's documentary at Newport's Quay Arts Centre.

And Newport Golf Club, which Milne established, has hosted its 99th annual John Milne Vase competition in his honour.

An exhibition of his life and work at Carisbrooke Castle earlier this year was unveiled by the Japanese ambassador.

(Stephen Stafford / BBC News Online, 31 July 2013, http://www.bbc.co.uk/news/uk-england-hampshire-23438077)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΛΟΙΠΑ

25 of mankind's greatest engineering achievements

Recent months have seen a fair number of impressive construction plans announced, from Norway's intention to create the world's first shipping tunnel to Maldives' plans for a space age underwater hotel to Dubai's plans for the world's biggest shopping mall.

How do these announcements stack up against what's already out there?

We've compiled 25 of what we think are some of the most impressive engineering/construction achievements to date, taking into consideration the era in which they were built and the knowledge and materials that were available to designers.

Many were inspired by the human impulse to travel, and those that weren't can be enjoyed by travelers today.

Engineering can, of course, also include electronics and other micro-feats -- arguably computers and smartphones are among the most successful, popular and influential pieces of engineering ever created -- but we're interested here in big, bold and brave.

The Palm, Dubai, UAE

The Palm islands comprise approximately 100 million cubic meters of rock and sand.

In total, 210 million cubic meters of rock, sand and limestone were reclaimed (through dredging) to create the islands, with 10 million cubic meters of rock used in the outer ring alone. The rocks used for both islands were transported from 16 quarries throughout the UAE and the materials used are enough to build a wall that could circle the world three times.

Completion date: September 24, 2008.

Aqueduct of Segovia, Segovia, Spain

The Aqueduct, one of the Iberian Peninsula's best preserved ancient monuments, features 44 double arches (or 88 when counted individually) and 79 single arches -- a total of 167.

It was built during the reign of Roman Emperor Trajan and is still in use today, carrying water from the Frío river to the town of Segovia. The bridge, which consists of 24,000 granite blocks, was constructed without the use of mortar and each of its 167 arches is more than nine meters high.

Completion date: AD 50.

Great Wall of China, China

The Great Wall of China is 8,850 kilometers long (5,500 miles) and was constructed over a period of 2,000 years. Construction began in 475 BC, to protect China from the invading Huns. During the Ming dynasty, between 1368 and 1644 A.D, it was given a makeover, with the addition of watchtowers, battlements and cannons -- some of which stand 980 meters above sea level. The mortar used to bind the stones of the wall is made from rice flour.

Completion date: 204 BC.

Taj Mahal, Agra, India

As many as 28 different varieties of semi-precious and precious stones were used to adorn the exterior of the Taj Mahal.

Construction of the Taj Mahal took around 20 years, beginning in around 1632 and finishing around 1653. Exact dates are unknown. The building, which was made from white marble from the quarries of Rajasthan, appears pink in the

morning, white in the day and golden in the moonlight. The building is symmetrical in every way, and was built as a memorial to the wife of Mughal emperor Shah Jahan.

Completion date: 1653.

Trans-Siberian Railway, Russia

The Trans-Siberian Railroad connects Moscow and Eastern Russia with Japan, China and Mongolia.

Northern Siberia isn't the easiest landscape to cross, which is what makes the 8,851-kilometer (5,500 mile) Trans-Siberian railway so impressive. Engineers had to design a railway that was capable of operating in temperatures of minus 20 degrees Celsius. The railway travels through eight time zones, 87 towns and cities and crosses 16 major rivers, including the Volga, Ob, Yenisey, Oka and Amur. Some 90,000 people helped construct the railway, which took 10 years to build -- pretty impressive considering the tools at workers' disposal were shovels, picks and wheelbarrows.

Completion date: 1904.

Burj Khalifa, Dubai, UAE

The Burj Khalifa has a height of 828 meters and is both the tallest building in the world and the tallest free-standing structure in the world. Engineers faced multiple challenges, including the strong winds that batter the tower. Because of this, over 40 wind tunnel tests were conducted, not just to determine how the wind would affect the building but also to test the cranes used to construct it.

Completion date: January 4, 2010.

Akashi Kaikyō Bridge, Akashi Strait, Japan

It took 2 million workers 10 years to construct the Akashi Kaikyo Bridge.

It connects the city of Kobe, on Japan's mainland, with Iwaya on Awaji Island. Before it opened, the only way to get between the two cities was by ferry. However, the waterway was prone to severe storms and when two ferries capsized in 1955, killing 168 people, public outrage convinced the government of the need for a bridge. It's the longest suspension bridge in the world, with a length of 1,991 meters.

Completion date: April 5, 1998.

White Pass and Yukon Route Railroad, Canada

Built during the Klondike Gold Rush and financed largely by British investors, the "railroad built on gold" was constructed in just 26 months, using 450 tons of explosives to blast through Canada's coastal mountains. Passengers should hold on tight -- the railroad climbs almost 278 meters in just 32 kilometers and has numerous other steep gradients of up to 4%.

The railway still uses vintage cars, the oldest dating back to 1881.

Completion date: July 29, 1900.

Tokyo Sky Tree, Tokyo

The Sky Tree's reinforced concrete center column is separate from the surrounding steel framing and incorporates an earthquake-resistant design similar to that used in pagoda temples.

Engineers really did reach for the sky when they built the 634-meter Tokyo Sky Tree in earthquake-prone Japan, although given that the company responsible for the design is the same company behind plans for a space elevator, we think the structure will be around for a good few years. It was built on notoriously unstable reclaimed ground, but engineers used a traditional Japanese building technique known as shinbashira, which relies on one central column to counterbalance seismic waves, greatly reducing the sway.

Completion date: May 22, 2012.

International Space Station

The International Space Station cost $100 billion to build and involved 100,000 people in 15 nations. It also ranks as one of the more unusual construction sites, located 354 kilometers (220 miles) above Earth. The hazards faced by those carrying out maintenance go far beyond a falling hammer or nail gun injury -- one tiny rip in a protective spacesuit means instant death.

Completion date: Ongoing.

Teotihuacan, Mexico

Teotihuacan is an Aztec name meaning "the place where men become Gods."

It was the largest city in the pre-Columbian Americas. The most famous structure is the Pyramid of the Sun, which was built in two phases. The second phase took its height to 224 meters, making it the third-tallest pyramid in the world. The entire city originally covered around 20 square kilometers (eight square miles) and was home to 2,200 structures, built with stone and lime plaster.

Completion date: 100 BC.

Panama Canal, Panama

More than 4.5 million cubic yards of concrete were used in the construction of this canal's locks and dams.

The Panama Canal is a 77-kilometer (47-mile) long waterway that connects the Atlantic and Pacific Oceans. The earth and rubble excavated to make way for it was enough to bury Manhattan to a depth of four meters. A series of locks controls the flow of water; each of the moveable lock doors weighs 750 tons and each of the locks fills with 52 million gallons of water to accommodate the 15,000 ships that use the canal every year.

Completion date: January 7, 1914.

Taipei 101, Taipei, Taiwan

Taipei 101 was the first building in the world to break through 500 meters.

Upon its completion, the tower claimed several records: it had the world's fastest elevator, was the world's tallest building and was the world's tallest structure, thanks to its spire. Eight "mega-columns" make the building especially earthquake resistant.

Completion date: December 31, 2004.

Grand Canyon Skywalk, Arizona

The Skywalk's foundation is strong enough to support 71 million pounds -- the equivalent of 71 fully loaded 747 airplanes.

Located 1,219 meters above the Colorado River, the Grand Canyon's Sky Walk consists of one million pounds of steel and 83,000 pounds of glass. It was the creation of Las Vegas businessman David Jin, who approached the Hualapai Tribe with the idea of a glass walkway over the Grand Canyon in 1996. The Skywalk was assembled on site, with the drilling alone taking over a year to complete.

Completion date: March 28, 2007.

Shanghai World Financial Center, Shanghai

The trapezoid-shaped opening near the top of the Shanghai World Financial Center reduces wind pressure on this 101-story-building.

When it was completed in 2008, the Shanghai World Financial Center became the second-tallest building in the world and the tallest building in mainland China, with a total height of 492 meters. Its most distinctive feature is its trapezoid, which is designed to reduce wind pressure and has earned the building the nickname "bottle opener." Visitors to the observation deck can purchase bottle openers in the shape of the building.

Completion date: July 17, 2008.

Millau Viaduct, Millau, France

The Millau Viaduct has the highest road bridge deck in Europe -- it sits 270 meters (890 feet) above the Tarn river at its highest point.

The Millau Viaduct is the world's tallest bridge, with a total height of 343 meters (886 ft), making it taller than the Eiffel Tower. The viaduct, which crosses the valley of the river Tarn, was created to ease traffic on the route between Paris and Spain. It cost €320 million ($412 million dollars) but offers good value for money, with a lifespan of 120 years.

Completion date: December 16, 2004.

London Underground, London

Aldgate Station, on the Circle, Hammersmith and City and Metropolitan Lines, is built on a huge plague pit, where more than 1,000 bodies were buried.

The London Underground celebrated its 150th birthday this year. The entire network has a length of 402 kilometers (249 miles) and more than 1 billion journeys are made every year. When it opened in 1863, it was the world's first underground railway and the trains, which traveled between Paddington and Farringdon, were gas-lit wooden carriages pulled by steam locomotives.

Completion date: January 10, 1863.

Kansai Airport, Osaka, Japan

Kansai International Airport was the first airport to be built on an artificial island.

Osaka is one of Japan's most crowded cities, so when a new airport was called for, engineers came up with a novel solution -- a man-made island. Construction of the island, which measures four kilometers (2.5 miles) by 2.5 kilometers (1.6 miles) took three years. Some 10,000 workers and 80 ships were used to excavate 21 million cubic meters of landfill and the island's construction became the world's most expensive civil engineering project, with a total cost of $20 billion.

Completion date: 1994.

Hoover Dam, Arizona/Nevada

Dam workers wore "hard hats" made by coating cloth hats with coal tar. These proved to be such an effective way to protect the workers' heads that the contractor, Six Companies, ordered commercially made hard hats of the same design.

The Hoover dam rises 221 meters above the Colorado River and resulted in the creation of Lake Mead, which is the largest man-made lake in the Western Hemisphere and feeds Las Vegas and neighboring towns. The dam is 210 meters thick at its base and 13 meters thick at its highest point. It's a gravity dam, which means that its foundations rely on gravity to keep the structure from collapsing.

Completion date: March 1, 1936.

Great Pyramid of Giza, Egypt

The Great Pyramid was the tallest man-made structure in the world for more than 3,800 years. The builders responsible for the Great Pyramid of Giza would have needed more than a few tea breaks to keep them motivated. The pyramid consists of 2.3 million stone blocks. The largest ones, found in the King's chamber, weigh between 25 and 80 tons and were transported to the site from Aswan, 800 kilometers away. In total, 5.5 million tons of limestone, 8,000 tons of granite and 500,000 tons of mortar were used. Experts have never worked out how the individual blocks were moved into place.

Completion date**:** 2504 BC.

Golden Gate Bridge, San Francisco

Each of the bridge's two main cables is made of 27,572 strands of wire.

Often referred to as "the bridge that couldn't be built," the Golden Gate Bridge crosses the stretch of water nicknamed "the Golden Gate" by gold prospectors heading to the Californian hills. Prior to 1937, San Francisco was America's largest city but its growth rate was slow compared to others, due to the lack of a link with other communities around the bay. The size of the strait (2,042 meters wide) combined with strong winds and regular earthquakes led many construction experts to say a bridge couldn't be built. The solution? Huge amounts of concrete, 128,747 kilometers (80,000 miles) of wire housed inside two cables, 600,000 rivets and a whole lot of hard work.

Completion date: May 27, 1937.

Eiffel Tower, Paris

Temperature alters the height of the Eiffel Tower by up to 6 inches (15 centimeters) over the year.

The Eiffel Tower weighs 13,200 tons and was the first building to surpass the height of the Great Pyramid of Giza. It remained the world's tallest building until 1929, when New York's Chrysler Building took the top spot. Gustave Eiffel's initial building plans and calculations were so precise that no revisions had to be made during the construction process.

Completion date: March 31, 1889.

Confederation Bridge, Prince Edward Island, Canada

The bridge's curve is designed to help drivers stay alert.

Before construction of Confederation Bridge, the only way to reach Prince Edward Island from Canada's mainland was by ferry or airplane.

The wind, waves and snow that batter the bridge, which links Canada's smallest province with New Brunswick, forced engineers to come up with a concrete mix that was 60% stronger than most. A purpose-built floating crane, the Svanen, was used to maneuver the individual sections (which included 65 reinforced concrete piers) into place.

Completion date: May 31, 1997.

Colosseum, Rome

The Colosseum could accommodate 50,000 spectators.

It's the largest amphitheater built by the Roman empire. It's estimated that the outer wall, which is 189 meters long and 156 meters wide, was originally built using 100,000 cubic meters of travertine stone. Some of this stone was later used in the construction of St Peter's Basilica and other nearby monuments.

Completion date: 80 AD.

CN Tower, Toronto, Canada

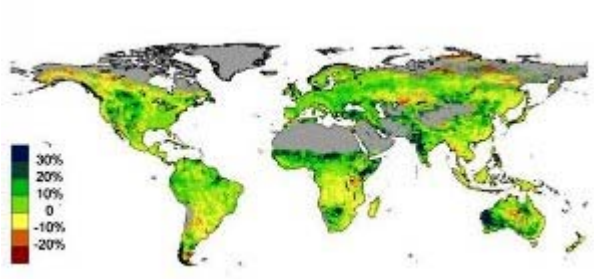
The CN Tower was built to withstand an earthquake of 8.5 on the Richter scale.

It was the world's tallest building when it was completed in 1976 and designed to withstand winds of up to 418 kph (260 mph). But strong winds and earthquakes are not the only factors the building has to contend with -- on average, lightning strikes the tower 75 times every year. Long copper strips, which run down the side of the building and are attached to grounding rods buried below ground, protect the structure from damage.

Completion date: October 1, 1976.

(Tamara Hinson / CNN, July 5, 2013, http://edition.cnn.com/2013/07/04/travel/engineering-feats/index.html)

Οι έρημοι του πλανήτη πρασινίζουν χάρη στη "γονιμοποίηση από διοξείδιο του άνθρακα"



Γνωρίζαμε ότι η υπερθέρμανση του πλανήτη και ιδίως οι αυξανόμενες θερμοκρασίες στο Βόρειο Ημισφαίριο έχουν συντελέσει σε σημαντικές αλλαγές στη βλάστηση και συγκεκριμένα στην αύξηση της χλωρίδας στον **Αρκτικό Κύκλο**.

Πλέον οι επιστήμονες υποστηρίζουν ότι τα **αυξημένα επίπεδα διοξειδίου του άνθρακα** στην ατμόσφαιρα συντελούν στο "πρασίνισμα" των ερήμων μέσω μιας διαδικασίας που ονομάζεται "γονιμοποίηση με διοξείδιο του άνθρακα".

Επιστήμονες του **Οργανισμού Επιστημονικής και Βιομηχανικής Έρευνας της Κοινοπολιτείας**(CSIRO), βασιζόμενοι σε δορυφορικές παρατηρήσεις 30 ετών, ανακάλυψαν ότι η χλωρίδα αυξήθηκε κατά 11% από το 1982 ως το 2010 σε περιοχές της Αυστραλίας, της Βόρειας Αμερικής, της Μέσης Ανατολής και της Αφρικής.

Η **γονιμοποίηση με διοξείδιο του άνθρακα** συμβαίνει όταν τα υψηλότερα επίπεδα διοξειδίου του άνθρακα επιτρέπουν στα φυτά να απορροφήσουν λιγότερο νερό στα φύλλα τους κατά τη διαδικασία της φωτοσύνθεσης.

Χρησιμοποιώντας δορυφορικές παρατηρήσεις και μαθηματικά μοντέλα οι επιστήμονες υπολόγισαν καταρχάς τα μέσα επίπεδα χλωρίδας για διάστημα τριών ετών τα οποία αντιστοίχησαν σε μεταβολές της υγρασίας εδάφους. Στη συνέχεια ομαδοποίησαν τις πληροφορίες ανά περιοχή με κριτήριο τα επίπεδα των βροχοπτώσεων.

Στόχος τους ήταν να **απομονώσουν** τις αυξήσεις στη χλωρίδα που οφείλονταν στις βροχοπτώσεις και να καταγράψουν τις μεταβολές σε βάθος τριακονταετίας.

Με μια πρώτη ματιά, τα αυξημένα επίπεδα διοξειδίου του άνθρακα τα οποία αυξάνουν τη χλωρίδα σε ξηρές περιοχές έχουν θετική **επίπτωση** και θα μπορούσαν να συμβάλλουν στη δημιουργία δασικών και καλλιεργήσιμων εκτάσεων. Παρόλα αυτά θα εμφανιστούν δευτερογενείς συνέπειες που θα επηρεάσουν τους υδροφόρους ορίζοντες, τον κύκλο του άνθρακα, την εκδήλωση πυρκαγιών και τη βιοποικιλότητα" επισημαίνει ο ερευνητής του CSIRO Δρ Ράνταλ Ντόνοχιου.

Κι ενώ αυτό συμβαίνει σε ορισμένες περιοχές, άλλες μαστίζονται από ξηρασία και ερημοποίηση.

(econews.gr, 16 Ιουλίου 2013)

Δράμα: Ανασκαφή φέρνει στο φως το χαμένο παρελθόν μιας απέραντης σαβάνας ηλικίας 9 εκατ. ετών

Τι αποκαλύπτουν τα απολιθώματα που εντοπίστηκαν στην Πλατανιά του Δήμου Παρανεστίου της Περιφερειακής Ενότητας Δράμας

Ρινόκεροι, καμηλοπαρδάλεις, γαζέλες, ιππάρια και αντιλόπες μας φέρνουν στο μυαλό εικόνες από την Αφρική. Κι όμως πριν από εννέα εκατομμύρια χρόνια όλη αυτή η πανίδα υπήρχε στη Δράμα καθιστώντας μια ευρύτερη περιοχή της ανατολικής Μακεδονίας σε μια απέραντη σαβάνα.

Αυτό αποκαλύπτουν τα απολιθώματα που εντοπίστηκαν στην Πλατανιά του Δήμου Παρανεστίου της Περιφερειακής Ενότητας Δράμας. Το ανασκαφικό έργο που πραγματοποιείται στην περιοχή έφερε στο φως πολύ σημαντικά παλαιοντολογικά ευρήματα από τα οποία προκύπτουν νέα στοιχεία για την ιστορία και τη γεωλογία της περιοχής.

Η ανασκαφική ομάδα του Αριστοτέλειου Πανεπιστημίου Θεσσαλονίκη με επικεφαλής την καθηγήτρια Γεωλογίας – Βιολογίας και Δρ Παλαιοντολογίας κ. Ευαγγελία Τσουκαλά διενεργεί ανασκαφικές έρευνες στην περιοχή τους τελευταίους επτά μήνες. Ωστόσο η αυτοψία της περιοχής ξεκίνησε πριν από ένα περίπου χρόνο μετά από παρότρυνση και υπόδειξη του δημάρχου Παρανεστίου Νίκου Καγιάογλου και κατοίκων της περιοχής που γνώριζαν την ύπαρξη των απολιθωμάτων.

Μιλώντας στο ΑΠΕ – ΜΠΕ η κ. Τσουκαλά δεν κρύβει την ικανοποίησή της από την πορεία των ανασκαφικών ερευνών και τα σημαντικά ευρήματα που εντοπίστηκαν.«Θεωρούμε ότι είναι τα αρχαιότερα που έχουν βρεθεί, όχι μόνο στην περιοχή της Δράμας, αλλά σε όλη την Ανατολική Μακεδονία και Θράκη», επισημαίνει η καθηγήτρια και συνεχίζει, «τα ευρήματα μας βοηθούν να γνωρίσουμε την ιστορία της Πλατανιάς, ότι ήταν δηλαδή μια σαβάνα πριν από εννέα εκατομμύρια χρόνια και μέσα σε αυτή ζούσαν ρινόκεροι, καμηλοπαρδάλεις, γαζέλες, ιππάρια, μαστόδοντες, που είναι οι πρόγονοι των ελεφάντων, ακόμη και αντιλόπες. Βρήκαμε μια πλούσια πανίδα εκείνης της εποχής στην περιοχή. Παρουσιάζει πολύ μεγάλο ενδιαφέρον να αναπαραστήσουμε το παλαιοπεριβάλλον αυτής της περιοχής και ν' αποδείξουμε τη διαχρονικότητά της».

Ερωτηθείσα αν τα συγκεκριμένα απολιθώματα είναι τα παλαιότερα σ' όλη την Ελλάδα, η κ. Τσουκαλά σημειώνει: «Είναι γνωστό ότι υπήρχαν ευρήματα και σε άλλες θέσεις, όπως τη Σάμο, τον Αξιό, το Πικέρμι, τα οποία έχουν δώσει απολιθώματα αυτής της ηλικίας και ότι η Ελλάδα ήταν πολύ διαφορετική απ' αυτή που γνωρίζουμε σήμερα. Αξίζει να αναφέρουμε ότι στη Λέσβο έχει χρονολογηθεί εύρημα στα 10 εκατομμύρια χρόνια. Ωστόσο, εξετάζοντας την περιοχή της Ανατολικής Μακεδονίας και Θράκης και ειδικότερα της Δράμας αυτό είναι κάτι το πρωτοφανές, αφού το παλαιότερο χρονικά εύρημα που είχε βρεθεί μέχρι σήμερα ήταν ένας μαστόδοντας στην Καλλίφυτο που χρονολογείται στα 2 - 5 εκατ. χρόνια, ενώ στο σπήλαιο του Μααρά υπάρχουν απολιθώματα 100.000 χρόνων. Έχουμε μια μεγάλη διαχρονικότητα στο παλαιοπεριβάλλον της περιοχής».

Αναφορικά με το πως ξεκίνησε το ανασκαφικό ενδιαφέρον στην περιοχή της Πλατανιάς η κ. Τσουκαλά τόνισε: «Κάτοικοι της Πλατανιάς δώσανε πληροφορίες στην καταγόμενη από την περιοχή, αρχαιολόγο Βασιλική Πουλιούδη, η οποία απευθύνθηκε στο ΑΠΘ. Με βάση αυτή την πληροφορία, προχωρήσαμε σε αυτοψία και εντοπίσαμε τις θέσεις πέρυσι τον Σεπτέμβρη. Ο κόσμος τα γνώριζε από παλιά. Έπαιρνε πηλό για να κατασκευάζει φούρνους. Μέσα σε πηλό βρέθηκαν αυτά τα απολιθώματα και πλέον όλοι κατανοούν τη σημαντικότητα των ευρημάτων. Τις ανασκαφές, πάντως, τις ξεκινήσαμε φέτος με τη συνδρομή του τμήματος Γεωλογίας – Βιολογίας. Κάναμε έρευνα περίπου μια εβδομάδα, μετά τον καθορισμό των θέσεων και βρήκαμε έναν πλούτο απολιθωμάτων, άρτια κρανία και καλά διατηρημένα από αντιλόπες, γαζέλες, ιππάρια. Όλα αυτά συνθέτουν ένα πλούσιο παλαιοντολογικό υλικό και προτιθέμεθα να διοργανώσουμε μια έκθεση στην περιοχή».

Ικανοποιημένος από την εξέλιξη των ανασκαφών, που έφεραν στο φως σπουδαία ευρήματα, εμφανίστηκε με δηλώσεις του στο ΑΠΕ – ΜΠΕ και ο δήμαρχος Παρανεστίου, Νίκος Καγιάογλου επισημαίνοντας ότι η ανασκαφή αυτή θα συμβάλει σημαντικά στην τουριστική ανάπτυξη της περιοχής, με όλα τα οφέλη που αυτό συνεπάγεται για την τοπική οικονομία.

«Όλα ξεκίνησαν από ένα ουζάκι που ήπιαμε με την κ. Πουλιούδη σε μαγαζί στην Πλατανιά», σημειώνει χαριτολογώντας ο δήμαρχος και συνεχίζει, «από την πρώτη στιγμή που της μεταφέραμε την πληροφόρηση, καταλάβαμε ότι κάτω από τα πόδια μας είχαμε μια ιστορία, τουλάχιστον εννέα εκατομμυρίων ετών. Για τη στέγαση των ευρημάτων υπήρξαν σκέψεις να αξιοποιηθεί ένα σχολείο, το οποίο δεν φιλοξενεί πλέον μαθητές και αυτό να μετατραπεί σε αρχαιολογικό μουσείο. Στόχος μας είναι οι ανασκαφές να συνεχιστούν. Από τη μεριά του Δήμου θα υπάρξει κάθε δυνατή στήριξη και ενίσχυση (είτε οικονομική, είτε ηθική) της προσπάθειας. Έχουμε αποφασίσει να απευθύνουμε ανάλογα αιτήματα στα αρμόδια υπουργεία ώστε να υπάρξει μια κάποια οικονομική ενίσχυση, αφού στόχος μας είναι να αναδείξουμε την περιοχή και να την αξιοποιήσουμε τουριστικά". Ο ίδιος εκτιμά πως "η συγκεκριμένη ανασκαφική έρευνα είναι μια μεγάλη υπόθεση, όχι μόνο για την Πλατανιά, αλλά για ολόκληρο το Δήμο Παρανεστίου καθώς θα προσφέρει σημαντικά οφέλη και μελλοντικά θα δημιουργήσει νέες θέσεις εργασίας».

(news247, 19 Ιουλίου 2013, http://news247.gr/eidiseis/koinonia/drama_anaskafh_fernei_sto_fws_to_xameno_parelthon_mias_aperanths_savanas_hlikias_9_ekat_etwn.2339113.html)

Fracking Could Help Geothermal Become a Power Player

Why isn't there more use of geothermal energy for power plants?

HOT ROCKS: Geothermal power is abundant, renewable and clean. So why isn't it employed more often? *Image: Photograph by Julie Donnelly-Nolan, USGS*

Here's another use for fracking: expanding access to hot rocks deep beneath Earth's surface for energy production. In April Ormat Technologies hooked up the first such project—known in the lingo as an enhanced geothermal system, or EGS—to the nation's electric grid near Reno, Nev.

"The big prize is EGS," enthuses Douglas Hollett, director of the Geothermal Technologies Office at the U.S. Department of Energy (DoE). "The key is learning how to do it in a reliable way, in a responsible way."

By some estimates, the U.S. could tap as much as 2,000 times the nation's current annual energy use of roughly 100 exajoules (an exajoule equals a quintillion, or 10^{18} joules) via enhanced geothermal technologies. With respect to electricity, the DoE concludes at least 500 gigawatts of electric capacity could be harvested from such EGS systems. Even better, hot rocks underlie every part of the country and the rest of the world. Australia's first enhanced geothermal system, spicily named Habanero, began producing power in May, and Europe has brought three such power plants online.

The idea is simple: pump water or other fluids down to the hot rocks beneath the surface. Heat from the rocks turns the water to steam. The steam rises and turns a turbine that spins a magnet to make electricity.

The technology is proved. For years people have turned naturally produced steam from hot springs and the like into electricity. A geothermal power plant in Larderello, Italy, has churned out electricity this way in Tuscany for more than a century, and big power plants can be built this way. The Geysers in California can produce 850 megawatts of electricity alone. But that's because the geothermal resource is close to the surface and obvious, thanks to hot steam rising into the sky.

Although similar natural bounty has turned Iceland into a geothermal powerhouse, there are only so many such sites around. That's where fracking, the controversial practice of pumping fluid underground to shatter shale and release oil or gas, can help. Fracking "enhances" geothermal by making cracks in hot rocks where none existed, allowing heat to be harvested from Earth's interior practically anywhere, although this reduces the total power produced because of the need to pump water through the system.

As an added benefit, however: geothermal power can run constantly—the hot rocks don't cool very fast—which makes it renewable and predictable. "Geothermal is homegrown, reliable and clean," says Rohit Khanna, program manager at the World Bank for its Energy Sector Management Assistance Program. That is a big part of the reason it is being pursued in developing countries such as Chile, Indonesia, Kenya and the Philippines.

In the case of the Philippines geothermal power now produces nearly 2,000 megawatts, or nearly 20 percent of the country's electricity, thanks to investments that were made in the 1990s. And Kenya, according to its ambassador to the U.S., Elkanah Odembo, would like to derive more than half its electricity from geothermal by 2030. The goal: a combination of geothermal and hydroelectric power that will make them entirely renewably powered. "The potential is there," Odembo promises. He says the Rift Valley contains an estimated 15 gigawatts of potential geothermal power. Nairobi has already become a boomtown for such development.

Yet, geothermal's abundant, renewable, clean potential for making electricity largely languishes, producing "less than 1 percent of global energy," according to a recent perspective in *Science*. Indeed, only 6 percent of naturally occurring geothermal resources have been tapped to date, according to Bloomberg New Energy Finance (BNEF).

The reason is simple: money. In addition to the $6-million to $8-million risk of drilling a dry hole or a well that does not produce steam as it should there is the multimillion-dollar expense of building a power plant on top of those wells that do produce steam as they should. That adds up to a total cost for a geothermal power plant of roughly $90 per megawatt-hour, which compares with $67 per megawatt-hour for a natural gas–fired power plant or $144 per megawatt-hour for photovoltaics, according to the DoE's Energy Information Administration.

That number only partially includes the big expense of exploring the geothermal resource in the first place. Gradient holes have to be drilled to explore a particular area. Explosions need to be set off at the surface to send seismic waves through the rock that allow for surveying the underground landscape—a technique familiar from the oil and gas industry. It can take years and millions of dollars to do this exploration with the prospect of earning that money back slowly via electricity sales—or all those funds could be lost. A project by Google and the University of Texas aims to help with that by using public information to develop maps of geothermal potential in the U.S.

BNEF puts the odds of successfully completing a geothermal well at 67 percent, which means one third of all geothermal projects fail. The analyst outfit has called for a "global geothermal exploration drilling fund" of some $500 million provided by investment agencies like the World Bank. Another problem: some EGS projects have been associated with small earthquakes, much like oil and gas drilling and waste-

water disposal. That has caused some projects to be abandoned.

As a result, there's a large role to play for supporting research and development to lower risks and improve the technology. The DoE, which invested in Ormat's Nevada project, also has programs to explore how to expand geothermal's reach. For example, it may be possible to take advantage of lower temperatures from cooler rocks found throughout the subsurface. The hot water co-produced with oil and gas wells could also be used to produce electricity. Slimmer test wells might decrease costs of exploration. Of course, better drilling technology developed for geothermal energy production may find a use in the oil and gas Industry first, such as the laser drilling being pioneered with the help of ARPA–E by Foro Energy. In fact, the oil and gas industry may find itself developing technology that can be applied to enhance geothermal. Their efforts to frack shales and free natural gas or oil require them to understand flow rates of fluid through the rock. "We know that has to tie into what we do," DoE's Hollett notes.

In the end, geothermal development may be best summed up by a song title: "Nice Work If You Can Get It," says BNEF analyst Mark Taylor. "If you have a great resource, demand for power and secure access to land, it's great. Without any of those things, it's really tough to get geothermal done."

Currently, the best place for enhanced geothermal systems in the U.S. is Nevada, particularly the northern part of the state, where there may well be more sheep than people and the government is a major landowner that favors renewable development. "Nevada in itself is having more projects than almost any country in the world," notes Benjamin Matek, an industry analyst for the Geothermal Energy Association. Maybe that should change.

(David Biello / Scientific American, July 29, 2013, http://www.scientificamerican.com/article.cfm?id=fracking-for-renewable-power-geothermal)

Notable failures in U.S. infrastructure in recent years

The nation's dams, roadways and other public works are aging, and some have faulty construction, but there is debate over funding their repairs and replacements

Skagit River Bridge — Washington state

A truck bumped against the steel framework of Interstate 5's Skagit River Bridge in Washington State, which collapsed, sending two vehicles and three people into the chilly water. The National Transportation Safety Board called the May 23 incident a wake-up call for the nation. About 71,000 vehicles crossed that span daily.

The Metrodome roof — Minneapolis

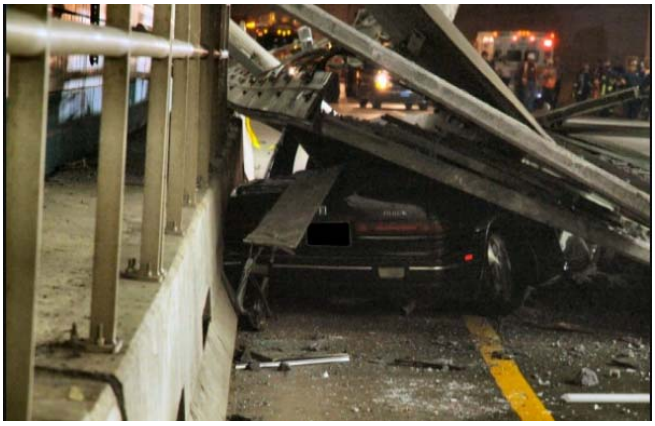
A winter storm collapsed the 580,000-pound fiberglass fabric roof, which was supported by air pressure. No one was injured when the roof collapsed at 5 a.m. on Dec. 12, 2010. The Minnesota Vikings and New York Giants had been scheduled to play that afternoon. The publicly funded and administered 31-year-old structure is slated to be demolished next year.

Interstate 35W bridge — Minneapolis

The bridge over the Mississippi River collapsed into sections during the evening rush hour of Aug. 1, 2007, killing 13 people and injuring 145. About 100 vehicles plunged as far as 115 feet into the water. A possible design flaw in the bridge was discovered — and the Federal Highway Administration urged states to inspect 700 bridges nationwide of similar construction. A replacement section of the bridge opened in 2008.

Big Dig ceiling — Boston

A three-ton, 20-by-40-foot section in Boston's Big Dig project collapsed on July 10, 2006, crushing a vehicle and killing its passenger. The collapse caused the closure of the tunnel, part of one of the nation's biggest public works projects, to close for nearly a year. An investigation found hundreds of dangerous bolt fixtures left by the construction company were holding together the tiles on the tunnel ceilings.



Taum Sauk reservoir — Missouri

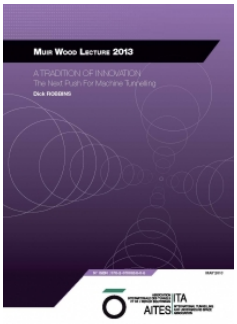
A section of the reservoir of the Taum Sauk Hydroelectric Power Station failed on Dec. 14, 2005, sending a 20-foot crest of water down the Black River. Five people were swept downstream by the wall of water, but no one was killed. A dam lower on the river held despite the onslaught of water, sparing several towns. The reservoir was rebuilt in 2010.

Breaches in canal levees — New Orleans

In 2005, Hurricane Katrina created what is considered the worst engineering disaster in the United States. More than 50 breaches were reported, flooding 80 percent of New Orleans. Most of the levees broke somewhere. At least 1,464 people were killed, and investigators cited the collapse poor reinforcement work done on the system of levees and canals.

(The Washington Post, 30 July 2013, http://www.washingtonpost.com/local/notable-failures-in-us-bridges-dams-and-stadiums-in-recent-years/2013/07/30/db3188f4-f8a2-11e2-b018-5b8251f0c56e_gallery.html#photo=6)

ΝΕΕΣ ΕΚΔΟΣΕΙΣ ΣΤΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΠΙΣΤΗΜΕΣ



A Tradition of Innovation
The Next Push For Machine Tunnelling

MUIR WOOD LECTURE 2013

Richard Robbins

As a relatively mature industry, the world of machine tunnelling is more conservative than it once was. While there is a place for standardized machinery and design elements on many projects, some projects require ingenuity and a progressive approach. Challenging and risky projects will always be a part of our industry and stepping out of the comfort zone of standardized technology on these tunnels is part of achieving success.

The effect of industry-wide conservatism is often the outcome of an effort to drive down risk, whether that is through contractual practices, industry regulations, or standardized technologies. However, all parties from contractor to equipment supplier to the project owner can be successful with challenging projects so long as the risks have been properly and fairly allocated.

(http://www.ita-aites.org/index.php?option=com_k2&view=item&id=650:muir-wood-lecture-2013)

Aggregates Handbook, Second Edition

For more than two decades, ***The Aggregates Handbook*** has been recognized as the industry's source for aggregates technology and knowledge.

This second edition incorporates new and updated material, including rapidly changing technologies in the aggregates industry. It includes expanded coverage of developments in sustainability, production technology, safety, transportation, design, technology standards, and industry trends.

Whether you are new to the industry, a seasoned professional, or simply curious about aggregates mining, you will find this volume informative and a valuable reference book.

CONTENTS

- Introduction to the Aggregates Industry
- Basic Properties of Aggregates
- Geology and Exploration
- Environmental Compliance
- Sustainability
- Industry Health and Safety
- Extraction Principles
- Processing Plant Principles
- The Marketplace
- Product Transportation and Distribution Systems
- Aggregates as s Structural Product
- Aggregates for Structural, Geotechnical, and Civil Engineering Applications
- Impact of Properties of Aggregates on Pavement Design and Analysis
- Effect of Aggregates on the Characteristics and Performance of Portland Cement Concrete
- Effect of Aggregates on the Characteristics and Performance of Hot Mix Asphalt
- Non-Construction Uses of Stone
- Specifications, Standards, and Guidelines for Aggregates Base Course
- Quality Control, Sampling, and Testing

(National Stone, Sand and Gravel Association, 2013)

Proceedings of the ICE - Ground Improvement

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- QA/QC for deep-mixed ground: current practice and future research needs
- Considerations for ensuring the durability of chemically stabilised road materials

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Thank you and Regards,

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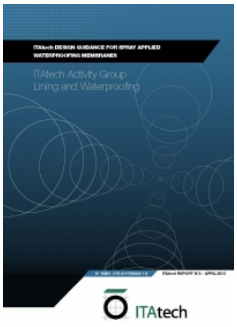
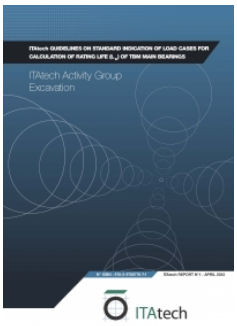
Journals Editor



Design Guidance for Spray Applied Waterproofing Membranes

This guidance document has been written to assist tunnel designers, contractors and owners in understanding the benefits of and limitations in the use of spray applied waterproofing membranes in excavated tunnels and shafts, and to provide guidance in drawing-up specifications and design details.

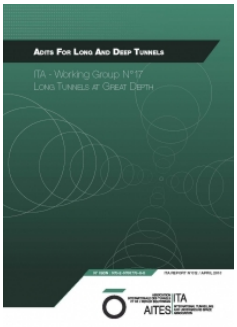
(ITAtech, http://www.ita-aites.org/fr/?option=com_k2&view=item&id=644:design-guidance-for-spray-applied-waterproofing-membranes&Itemid=895)



Guidelines on Standard Indication of Load Cases for Calculation of Rating Life (L10) of TBM Main Bearings

Tunnel owners, consultants, and contractors require assurance of adequate Main Bearing L10 Life for Tunnel Boring Machines with rotary cutterheads. This document sets out a standardized method of indicating the Main Bearing Load Assumptions. It provides a common baseline to facilitate the comparison of load assumptions and therefore the resulting L10 bearing lives offered by various tunneling machine manufacturers.

(ITAtech, http://www.ita-aites.org/fr/?option=com_k2&view=item&id=643:guidelines-on-standard-indication-of-load-cases-for-calculation-of-rating-life-l10-of-tbm-main-bearings&Itemid=895)



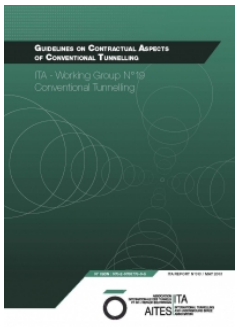
Adits for Long and Deep Tunnels

In 2010, the ITA-working group N°17 published a revised version of the report entitled long Tunnels at great depth.

The original 2003 report was revised to take into account the experiences of long traffic tunnels at great depths in the Alps. The Lötschberg base tunnel (Switzerland) was commissioned in 2006, and the Gotthard base tunnel was broken through in 2011. Investigation work is under way for the Lyon-Turin (France – Italy) and Brenner base tunnel projects.

This revision has also incorporated experiences from projects in China, Japan, Norway and Sweden, where projects are currently underway.

(ITAtech, http://www.ita-aites.org/fr/?option=com_k2&view=item&id=625:aditsforlongand-deep-tunnels)



Guidelines on Contractual Aspects of Conventional Tunnelling

Underground construction is clearly different from any other type of construction since the properties of the construction material – the ground conditions – cannot be precisely known. Unforeseen conditions, dependency on the means and methods, and unavoidable construction risks are typical for underground construction in general, and specifically for conventional tunnelling. Contracting practices for tunnels and underground structures must therefore be dealt with differently from other types of construction.

(ITAtech, http://www.ita-aites.org/fr/?option=com_k2&view=item&id=626:guidelines-on-contractual-aspects-of-conventional-tunnelling)

ΗΛΕΚΤΡΟΝΙΚΑ ΠΕΡΙΟΔΙΚΑ

INTERNATIONAL TUNNELLING AND UNDERGROUND SPACE ASSOCIATION
ita@news n°50
www.ita-aites.org

Κυκλοφόρησε το Τεύχος No. 50 – Ιούλιος 2013 των ita@news της International Tunnelling Association με τα παρακάτω περιεχόμενα:

- Message from Soren EsKESEN, ITA President
- ITA has a new President
- WTC 2013 - a real success
- Deadline for Abstracts for WTC is next week
- Global Perspective 2013
- ITA handover a video to UNISDR
- MoU signed with UN Habitat
- International Tunnelling Awards
- New Member Nation representative for Saudi Arabia
- Muir Wood lecture 2013
- Design guidance For spray Applied Waterproofing Membranes
- Guidelines on standard indication of Load Cases for calculation of Rating Life (l10) of TBM main bearings
- Adits for Long and Deep Tunnels
- Guidelines on Contractual Aspects of Conventional Tunnelling

Geosynthetics International
www.thomastelford.com/journals

Κυκλοφόρησε το τεύχος αρ. 4 του 20ου τόμου (Αυγούστου 2013) του περιοδικού **Geosynthetics International** με τα ακόλουθα περιεχόμενα:

- M. X. Zhang, C. C. Qiu, A. A. Javadi, Y. Lu & S.L. Zhang "Discrete-element method simulation of a model test of an embankment reinforced with horizontal–vertical inclusions"
- M. S. S. Almeida, I. Hosseinpour & M. Riccio "Performance of a geosynthetic-encased column (GEC) in soft ground: numerical and analytical studies"
- M. Olgun "Effects of polypropylene fiber inclusion on the strength and volume change characteristics of cement-fly ash stabilized clay soil"
- M. B. D. Elsawy "Behaviour of soft ground improved by conventional and geogrid-encased stone columns, based on FEM study"
- B. Fatahi, B. Fatahi, T. M. Le & H. Khabbaz "Small-strain properties of soft clay treated with fibre and cement"

Πρόσβαση μέσω της ιστοσελίδας
http://www.icevirtuallibrary.com/content/issue/gein/20/4

www.geoengineer.org

Κυκλοφόρησε το εορταστικό Τεύχος #102 του **Newsletter του Geoengineer.org** (Ιούλιος 2013) με πολλές χρήσιμες πληροφορίες για όλα τα θέματα της γεωτεχνικής μηχανικής. Υπενθυμίζεται ότι το Newsletter εκδίδεται από τον συνάδελφο και μέλος της ΕΕΕΕΓΜ Δημήτρη Ζέκκο (secretariat@geoengineer.org).

Geotextiles & Geomembranes
www.geosyntheticssociety.org/journals.htm

Κυκλοφόρησε ο τόμος 38 (Αυγούστου 2013) με τα παρακάτω περιεχόμενα:

Rao Martand Singh & Abdelmalek Bouazza "Thermal conductivity of geosynthetics", pp. 1-8

Eder C.G. Santos, Ennio M. Palmeira & Richard J. Bathurst "Behaviour of a geogrid reinforced wall built with recycled

construction and demolition waste backfill on a collapsible foundation", pp. 9-19

Buddhima Indraratna, Syed Khaja Karimullah Hussaini & J.S. Vinod "The lateral displacement response of geogrid-reinforced ballast under cyclic loading", pp. 20-29

Ikiensinma Gogo-Abite & Manoj Chopra "Performance evaluation of two silt fence geotextiles using a tilting test-bed with simulated rainfall", pp. 30-38

Maxime Soudé, Bastien Chevalier, Michel Grédiac, Aurélie Talon & Roland Gourvès "Experimental and numerical investigation of the response of geocell-reinforced walls to horizontal localized impact", pp. 39-50

Rong-Her Chen, Chang-Ping Wu, Feng-Chi Huang & Che-Wei Shen "Numerical analysis of geocell-reinforced retaining structures", pp. 51-62

Πρόσβαση μέσω τις ιστοσελίδας:
http://www.sciencedirect.com/science/journal/02661144

http://icold-cigb.net/userfiles/files/NEWSLETTERS/ICOLD-NL2013-BD.pdf

Κυκλοφόρησε το Τεύχος 13 (Ιούλιος 2013) του **The Dams Newsletter** της **International Commission on Large Dams** με τα παρακάτω περιεχόμενα:

- Editorial
- ICOLD News
  - Africa 2013 a resounding success! p.3
  - 9th Symposium of the ICOLD European Club, Venice p.4
  - ICOLD President attended the kick off meeting of the 7th World Water Forum p.7
- News about Dams
  - African Water p.9
  - Worldwatch Institute p.10
- ICOLD Energy in a new light
  - Water-Energy nexus enters new phase p.12
- ICOLD Vice-President's Corner
  - Actually, ICOLD is a Magnificent Organization p.14
- ICOLD Activities p.16

http://www.itacet.org/Newsletter/16_2013/ITACET_NL_16_2013.php

Κυκλοφόρησε το Τεύχος No. 16 (Ιούλιος 2013) του ITACET Foundation με τα παρακάτω περιεχόμενα:

- President's address
- Editorial: Søren Degn Eskesen, ITA-AITES President
- Tunnelling in Limestone
- WTC Training Session in Geneva
- Principles in Tunnelling Design
- Immersed Tunnels
- MAS in Tunnelling
- Next Events

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