Dark Star Uzbekistan Cliff - Man Climb

Αρ. 97 – ΔΕΚΕΜΒΡΙΟΣ 2016

ΕΛΛΗΝΙΚΗ ΕΠΙΣΤΗΜΟΝΙΚΗ ΕΤΑΙΡΕΙΑ ΕΔΑΦΟΜΗΧΑΝΙΚΗΣ & ΓΕΩΤΕΧΝΙΚΗΣ ΜΗΧΑΝΙΚΗΣ

Τα Νέα της Ε Ε Ε Ε Γ Μ

97

When are Black Swans White ?

A new term has become popular among people when they talk about risk, including some risk specialists. The phrase "Black Swan" is taken from the title of the 2007 book by Nicholas Nassim Taleb called "The Black Swan: The impact of the highly improbable". Unfortunately the way most people use this term is different from Taleb's original definition. In popular conversation the Black Swan event is something with an extremely low likelihood of occurrence and an extremely high potential effect. It is seen as the thing that we think will never happen, but if it did happen then we would really be affected in a big way. By contrast, in his book Taleb says Black Swans have three characteristics: they are unexpected and unpredictable outliers, they have extreme impacts, and they appear obvious after they have happened.

The term comes from the idea that in the Western world a few centuries ago, it was a known fact that all swans were white. Any similar bird of a different colour could not be a swan, by definition. Then explorers travelled to Australia in 1697 and discovered true swans that were black, and the known fact had to be modified in the light of new evidence. In today's world the Black Swan changes the rules and creates a new paradigm. Examples include the fall of the Berlin Wall, the 11 September 2001 terrorist attacks in America, the rise of Google, or the recent financial crisis.

Events or circumstances with extremely low probability and extremely high impact are in fact just risks and they can and

(συνέχεια στην σελίδα 3)

Π Ε Ρ Ι Ε Χ Ο Μ Ε Ν Α

Badlands National Park, South Dakota, USA

Watkins Glen State Park, New York, USA

Grand Prismatic Spring, Wyoming, USA

Hamilton Pool, Texas, USA

(συνέχεια από την πρώτη σελίδα)

should be tackled through the normal risk process. There is no useful reason to give them the special name of Black Swans.

Another popular use of the "Black Swan" term is to describe "unknown unknowns", which are things that we do not know but where we are unaware of our ignorance. This is nearly right, but not quite. In fact "unknown unknowns" can be divided into two types, one of which is a true Black Swan and the other is not.

1. The first group are "unknown-but-knowable unknowns". There are some uncertainties that we currently do not know, but which we could find out about. This is where the risk process can help, through creative risk identification, exploration and education. The aim is to expose those unknowns that could be known, so that we can deal with them effectively using a standard risk management approach. They are not Black Swans because we could know about them if our predictive or discovery processes were better.

2. Secondly there are "unknown-but-unknowable unknowns". These are much more difficult to deal with, since by definition we can never discover them unless and until they happen. These are the true Black Swans, which we could not predict with even the best risk process. Risk management cannot help us here, since it only targets uncertainties that can be seen in advance and which we can prepare for or address proactively.

If we cannot use risk management to address Black Swans in advance, is there anything else we can do? At the strategic level, business continuity can help us deal with "unknown-but-unknowable unknowns". This approach identifies areas of vulnerability and ensures that we build in resilience and flexibility so that we can cope with the impact of the unexpected, wherever it comes from. Business continuity also looks for early warning indicators or trigger events to tell us that something is different from normal. Finally it uses environmental scanning to help us discover potential Black Swans before they strike. It is possible to apply this at other levels in the organisation, including for projects and programmes or at operational level, creating an "enterprise-wide continuity" approach.

The Black Swan is a valuable concept that warns us to expect the unexpected. The only certainty is uncertainty, and we know that we will continue to be surprised in all areas of life, including both personal and professional. We should be careful to use the term properly and not dilute it through misuse or laziness. If we mistakenly think that risks with very low probability and very high impact are Black Swans, then we are likely to remain blind to the existence of true Black Swans. That in turn will leave us unaware of how vulnerable we are to genuinely unknowable unknowns.

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To provide feedback on this Briefing Note, or for more details on how to develop effective risk management, contact the Risk Doctor (info@risk-doctor.com), or visit the Risk Doctor website (www.risk-doctor.com).

The Black Swan concept warns us to expect the unexpected

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εν οίδα ότι ουδέν οίδα
ΣΩΚΡΑΤΗΣ

ΑΡΘΡΑ

Παρουσίαση άρθρων, στην συγγραφή των οποίων μετείχαν Έλληνες, στο XVI European Conference on Soil Mechanics and Geotechnical Engineering, Edinburgh, 13-17 September 2015 (κατ' αλφαβητική σειρά, στα ελληνικά, του ονόματος του πρώτου συγγραφέα).

Numerical modelling of offshore pile driving

Modélisation numérique de battage de pieux en mer

C. Pop, V. Zania and B. Trimoreau

ABSTRACT The number of offshore pile driving activities is increasing, following the growth of offshore wind farms in European waters. The most popular deep foundation employed at present for offshore turbines is the monopile that is driven into the seabed. The installation of these large diameter steel piles is achieved by using hydraulic hammers and applying enormous impact energy. Pile driving generates high-pressure acoustic waves in the surrounding water and sediments and therefore, environmental concerns in connection with marine life have been raised. Noise regulations are in place in German waters, so the necessity to predict and model noise propagation has arisen to optimize mitigation measures. The underwater noise that is produced during pile driving is mostly due to a radial expansion wave propagating along the pile after impact that generates conical acoustic wavefronts in the surroundings. The current study aims at investigating the dynamic pile-water-soil system by means of finite element modelling. The loss mechanisms experienced by the structural waves at the pile-sediment interface and by the body waves in the soil need to be accounted for to accurately estimate the received acoustic waves in the water. Axisymmetric finite element models are developed where the soil is considered homogeneous continuum with linear elastic material behaviour. Appropriate boundary conditions are also implemented in order to treat the semi-infinite domains of both water and soil, thus to avoid any spurious wave reflections at the boundaries. The effect of various soil conditions is investigated through a parametric study.

1 INTRODUCTION

The most popular deep foundations of offshore wind turbines so far are large diameter (2-7m) steel monopiles, driven in the seabed by impact. The released energy during impact is transformed to high-pressure acoustic (compression) waves in the surrounding air, water and soil sediment which generate underwater noise (Reinhall & Dahl 2011). Concerns on the negative environmental impact of underwater noise related mainly to the marine mammals have been raised. Thereafter extensive monitoring programs have been implemented during the construction and operational period of offshore wind farms. Nonetheless noise regulations are already in place in German waters through the BSH guidelines for certification of offshore wind farms (Müller & Zerbs 2011). Therefore along with the growth of offshore wind farms, the necessity to predict and model underwater noise has arisen.

The radial oscillations of the pile wall generated due to the Poisson's effect by the compression wave after the impact is the main source of the acoustic waves within the water (Reinhall & Dahl 2011). However three main transmission paths have been identified: (a) the direct pile-water path, (b) the indirect pile-soil-water path, and (c) the indirect pile-airwater path which is often disregarded due to its minor contribution (Lippert et al. 2013). A realistic estimation of the underwater noise levels requires efficient modelling of the two major transmission paths, hence pile-water interaction, pile-soil interaction, water-soil coupling and wave propagation within the soil medium.

The numerical methods available in the literature to analyse pile driving can be classified as: (a) lumped parameter models (Smith 1960, and Randolph 2003), (b) continuum finite element models (Masouleh & Fakharian 2007; Masoumi et al. 2007), and (c) acoustic finite element models (Reinhall & Dahl 2011; Milatz et al. 2012).The drawbacks of the abovementioned methods can be summarized as: (a) lumped parameter models do not account for the water medium, the coupling effect between the water and seabed, and the propagation of non plane strain waves within the soil, (b) continuum finite element models disregard usually the water medium, therefore underwater noise estimation is not possible, (c) acoustic finite element models do not capture phenomena such as bottom loss due to the acoustic wave propagation in the water, interface wave generation at the water-seabed boundary, energy dissipation via hysteretic damping, since the soil constitutive behaviour is simplified to equivalent fluid.

In the current study a hybrid (acoustic for the water domain and continuum for the soil domain) nearfield (up to 80m from the shaft) complete interaction model is developed, capturing wave propagation along the two major transmission paths. The approach is compared to the corresponding acoustic finite element model in order to highlight the limitations of the latter. A parametric study is conducted to investigate the role of the soil stiffness on the hydroacoustic pressure.

2 METHODOLOGY

The hybrid finite element model developed in the current study to investigate the acoustic radiation due to impact driving is shown in Figure 1. Axisymmetric modelling is employed and the explicit integration solver of the commercial software Abaqus is used for the analysis. The explicit time integration is chosen due to the reduction of computational cost.

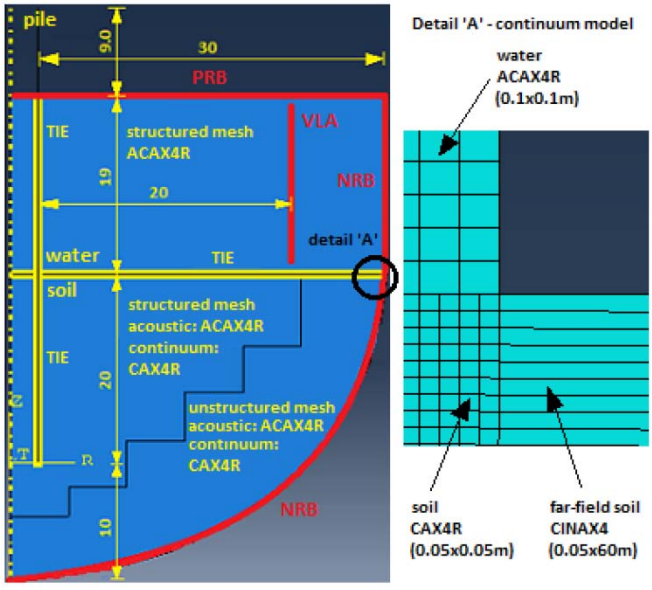

Figure 1. Finite element model geometry, meshing and boundary conditions.

The mesh size for each domain of the model is established based on the minimum wave speed characterizing the material (c_{min}) and the maximum exciting frequency (f_{max}) that needs to be captured, such as at least six elements per wavelength are provided (Milatz et al. 2012). An equivalent acoustic model is also developed, where the soil is modelled

as fluid. The type and element size of the two finite element models is depicted in Figure 1. The sea surface is modelled as a pressure-release boundary (PRB) due to the almost zero impedance contrast between air and water. The far-field effect of the acoustic media (water and fluid soil) is modelled through improved simple impedance boundaries (non-reflecting boundaries – NRB). These boundaries prevent spurious wave reflections at the media edges for any incidence angle. In the continuum approach the far-field effect of the soil is modelled using infinite elements (CINAX4) which are non-reflecting boundaries as well (Figure 1). The load function applied at the pile head as a pressure load to simulate the hammer impact has been selected as in other studies in the literature (Zampolli et al. 2013) (Figure 2).

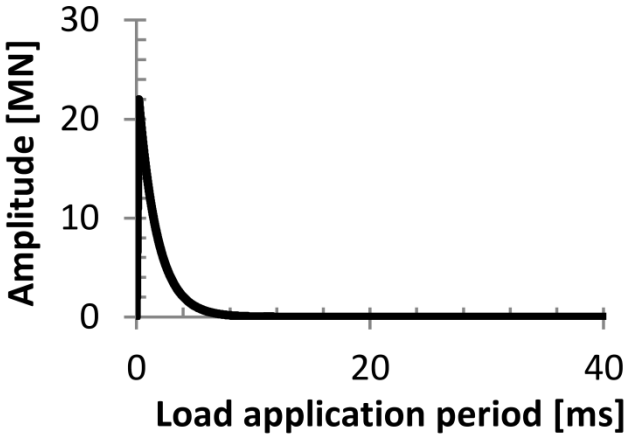

Figure 2. Load function used for simulating the hammer impact.

The sound speed profile within the fluid domain is assumed constant. The water density is set as 1024kg/m^3, while the sound speed as 1480m/s.

The soil is considered a homogeneous continuum medium with linear elastic material behaviour. In the hybrid model, the linear elastic soil is characterised by Poisson's ratio, v_s, Young's modulus, E_s and the material density, ρ_s. The compressional or P-wave velocity is determined as function of the saturation (Verruijt 2005). Saturated soils attain higher compressional wave speed, than dry soils, due to the increase in volumetric stiffness by the pore water. Since the soil is assumed here to be saturated but is modelled as a continuum and not two phase material, the pore water cannot be accounted for directly in the numerical model. Thus, for obtaining the same c_p as for the fluid soil, the elastic parameters (v_s and E_s) are calibrated to derive the correct shear and compressional wave velocities (c_p and c_s) within the soil (see Table 1).

Table 1. Stiffness properties for the soil domain

Model no.	Soil stiffness	ρ [kg/m^3]	c_p [m/s]	c_s [m/s]
1	acoustic	1900	1700	0
2	stiff	1900	1700	400
3	medium	1900	1700	200
4	soft	1900	1700	50

For direct comparison of the wave propagation in the acoustic (model 1) and the hybrid (model 2) models, the soil is initially considered to be stiff, with c_s=400m/s. The effect of different soil conditions (softer soils) on the wave propagation in the water and soil domains is investigated later on by a parametric study (models 3 and 4). The geometry and material properties of the steel monopile are the kept constant throughout the current investigation (ρ_p=7800kg/m^3, E_p=207x10^{9}Pa, v_p=0.3). The pile dimensions are: 48m length, 4.8m diameter and 0.05m wall thickness. Displacement compatibility between the different domains of the model (pile, water, soil) is materialized by tied constraints at the common interfaces. Therefore, at the pile-soil interface, no slip can occur between the two parts. Thus, the energy dissipation at the pile shaft through interface friction is not considered in this model. An analysis of the single pile to impact is also performed.

3 WAVE PROPAGATION ANALYSIS

3.1 Wave propagation in the pile

The soil shear stiffness effect on the wave propagation in the pile is observed by plotting the axial stress time history for a point on the pile 7.0m below seafloor in three cases: single pile rigidly supported at the tip, model 1 and model 2 (Figure 3).

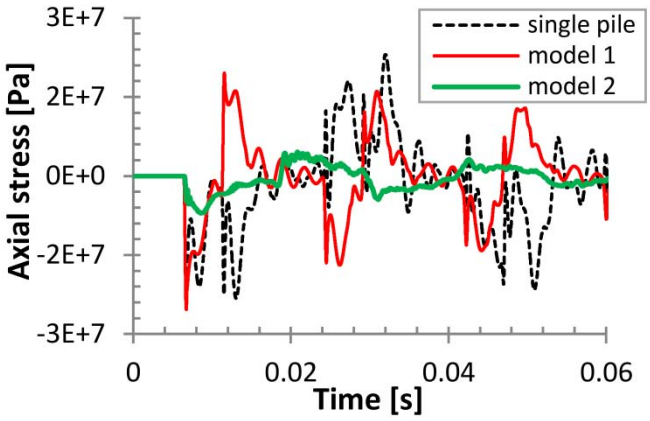

Figure 3. Axial stress time history in the pile 7.0m below seafloor.

The first peak amplitudes – which represent the initial downward compressive wave – are equal only for the first two cases, i.e. single pile and model 1. In model 2 a significant amplitude decrease is observed for the first peak. At this location, the initial stress wave has already travelled 7.0m in the embedded part of the pile. Consequently, the amplitude reduction for the first peak – compared to the other two cases- is caused by the axial strain reduction due to the soil shear stiffness encountered along the propagation over the embedded first 7.0m. The soil shear stiffness causes a resistance against the development of the axial strains, thus a reduction in the axial stress amplitude. In model 2, there is also a delay in the wave arrival time compared to the other two models, which is also attributed to the soil shear stiffness.

3.2 Wave propagation in the acoustic model

Since the compression wave travels faster in the pile (c_p=5151m/s) than in the water (c_p=1480m/s) or the fluid seabed (c_p=1700m/s), the primary spherical wave fronts produced by the oscillation of each point on the pile will overlap (Heitmann et al. 2013). Due to the time lag between the emissions of consecutive spherical fronts, there will also be a difference in the volume covered which leads to the final acoustic field with conical shape. The conical field observed in other studies (Reinhall & Dahl 2011; Heitmann et al. 2013), is captured in model 1 as well as shown by the hydroacoustic pressure contour snapshots shown in Figure 4. The compressive nature of the first downward propagating wave in the pile causes the first acoustic front to be compressive as well, as it can be seen in the snapshot at 9.0ms. The subsequent wave fronts belong to the first downward propagating cone, visible in the same screenshot, and alternate in phase as they are caused by the pile wall oscillations after the initial wave has passed.

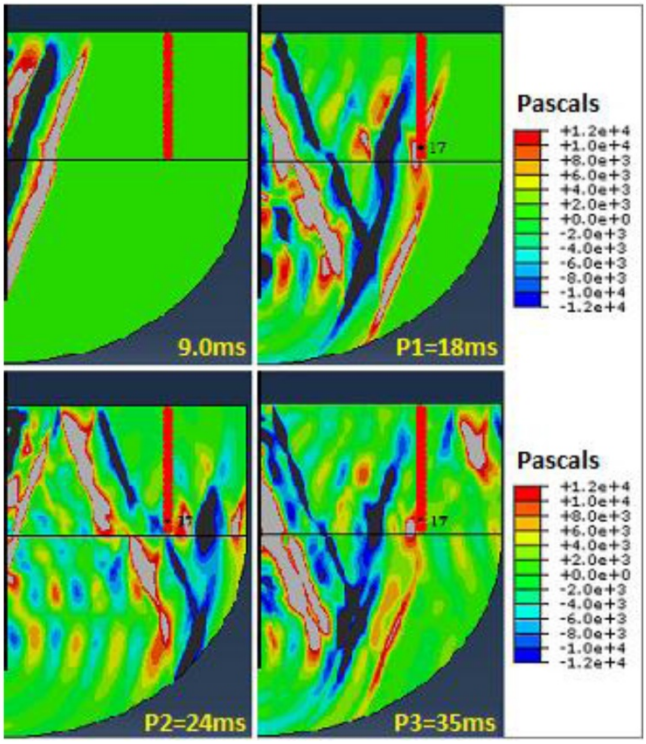

Figure 4. Hydroacoustic pressure contours snapshots. The wave fronts in model 1 are shown.

3.3 Wave propagation in the continuum model

Pile-driving induces P-waves in the soil caused as in the acoustic approach by the radial expansion wave in the pile and vertically polarized shear waves caused by the shear deformation induced at the shaft during driving. This is visible as the pressure stress (P-waves) and deviatoric stress (S-waves) contour plots at Figure 5.

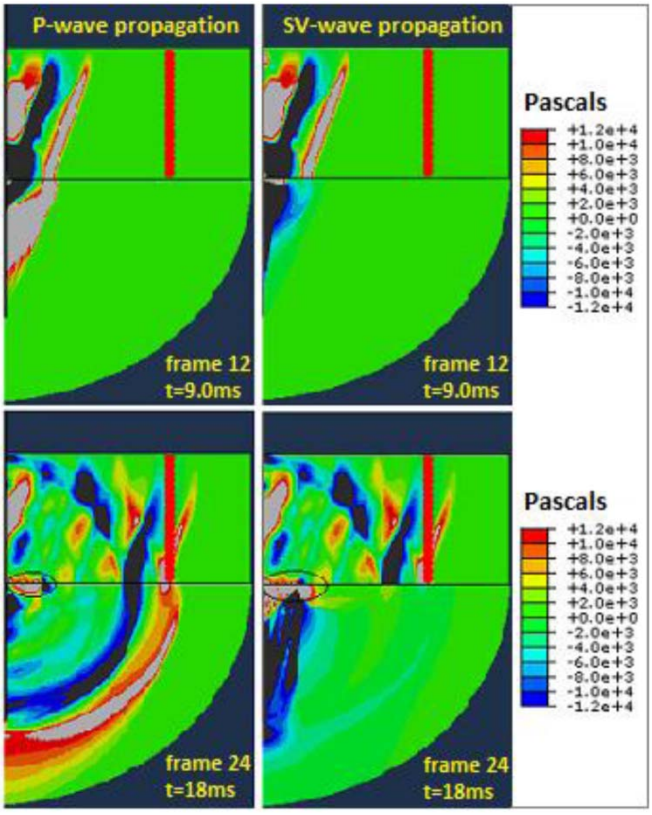

Figure 5. Pressure and deviatoric stress contour plots depict the P and SV-wave front propagations respectively in model 2.

It has been observed that until at least a distance from the shaft equal to the embedded depth of the pile and for this magnitude of shear stiffness, the shear waves propagating on a cylindrical front dominate the propagation around the shaft. This aspect has been observed in other studies as well (Masoumi et al. 2007). Stress concentration areas have been identified at the water-soil interface visible at time equal to 18ms in the contour plots showing the P and SV-wave front propagations (Figure 5). This is attributed to generation of interface Scholte waves which contain both P and SV components and occur at the boundary between a fluid and solid, due to the discontinuity in shear stresses at this location. The Scholte wave speed determined using the analytical solution (Dong & Hovem 2011) yielded similar value to the one estimated from the numerical solution ($v_{scholte}$=354m/s), which supports the fact that the wave observed at the water-soil interface is indeed the Scholte wave. The numerical wave speed has been estimated after the wave arrival time, detected by plotting a synthetic seismogram of the P-wave component (Figure 6).

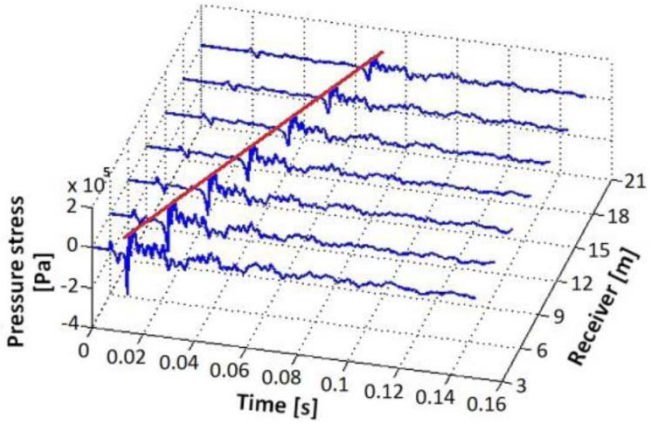

Figure 6. Synthetic seismogram of P-wave component for detecting the interface Scholte wave.

3.4 Hydroacoustic pressure variations

In order to highlight the differences between the acoustic and the continuum soil modelling, the acoustic pressure variation is plotted 20m from the shaft and 2.0m above the seabed (Figure 7).

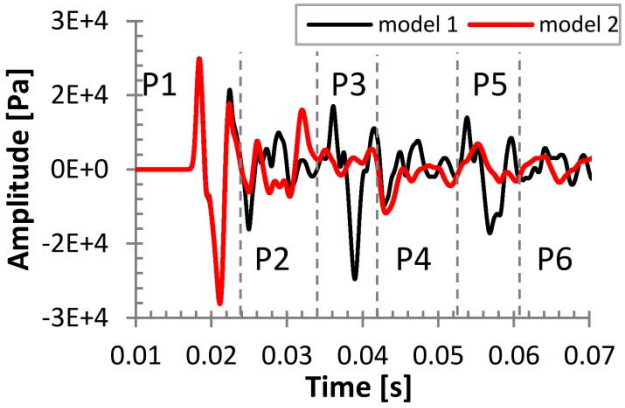

Figure 7. Comparison of the hydroacoustic pressure time histories obtained

In the acoustic model, a clear phase division representing the downward and upward propagating cones can be observed. Phase 1 (P1) captures the first three wave fronts belonging to the initial downward propagating cone in the water (Figure 4 – 18ms). This phase is naturally captured in the hybrid model as well. However, a decrease can be observed in the third peak's amplitude. This occurs since the

third front experiences the additional bottom loss mechanisms associated with the shear waves. The soil shear stiffness represents an additional degree of freedom for the acoustic wave to penetrate into the soil (shear wave conversion). Thus, the energy loss experienced by the acoustic waves in the water at the seafloor level is represented in the hybrid model.

In model 1, P3 (Figure 4 – 35ms) and P5 are a repetition of P1, being caused by the second and third downward propagating cones. P2 (Figure 4 – 24ms), P4 and P6 are caused by the upward propagating cones after wave reflection occurs at the pile tip. In model 2, the upward cones in the soil and water are not visible for this high level of shear stiffness. This is caused by the significantly decreased radial strains in the pile due to the presence of the soil shear stiffness. For this reason, the hydroacoustic pressure from the direct pile-water path is decreased as well.

4 PARAMETRIC STUDY

The soil shear stiffness plays a fundamental role in the wave propagation, bottom loss and acoustic pressure generation within the complete interaction model. In order to investigate the effect of the soil shear stiffness, models 3 and 4 are analysed (soil properties are listed in Table 1).

Investigating the P wave propagation in the four studied models, it appears that the upward and downward propagating cones in both water and soil media are clearly distinguishable in model 4, similarly to model 1 (Figure 8), but with reduced amplitude due to the decrease in axial strains in the pile because of the small, but present soil shear stiffness. On the contrary, for the stiffer soils (models 2 and 3) the pressure cones do not develop anymore.

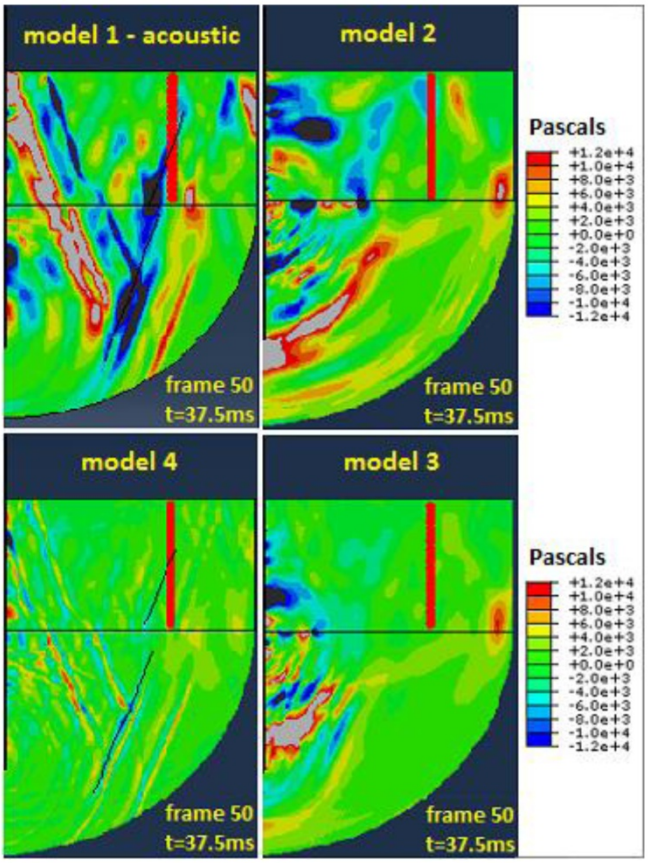

Figure 8. Soil shear stiffness effect on the compressional wave propagation.

Another observation of the parametric study is that for soils with considerable shear stiffness ($c_s \geq 200$m/s), the shear waves dominate the propagation around the shaft, while in the case of soft soils the propagation is dominated by compression waves. Hence, the acoustic modelling approach may represent a fair approximation of the wave propagation for very soft soils. The Scholte wave penetration depth into the water is investigated for models 2 and 3 through penetration envelopes that describe the penetrations of a wave in a certain location at subsequent times (Figure 9). By comparing the two envelopes, it appears that the penetration into the water increases with increasing soil shear stiffness. This effect has been observed in one recent study as well (Tsouvalas & Metrikine 2014). Comparing the acoustic pressure amplitudes along the penetration in the two models, it is evident that the energy carried by the Scholte wave in the water increases with increasing soil shear stiffness. Consequently, the hydroacoustic pressure close to the seafloor is likely to contain Scholte wave energy and affect the underwater noise.

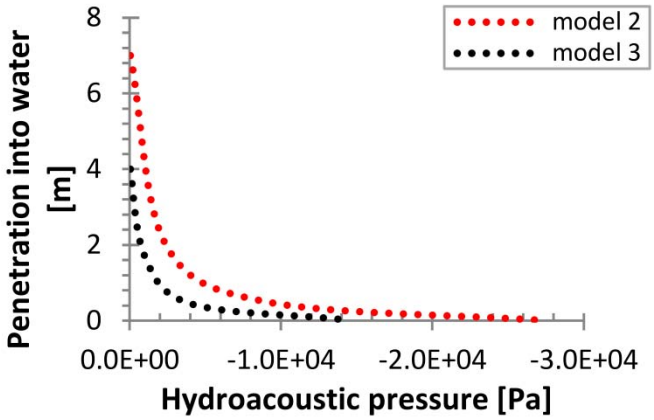

Figure 9. Variation of Scholte wave penetration into the water medium with soil shear stiffness

5 CONCLUSIONS

In the study, a hybrid finite element model has been developed to investigate the wave propagation in the complete pile-soil-water interaction system. The numerical model was able to capture the full wave propagation in both the water and soil media, including the vertically polarized shear waves in the soil, the Scholte waves at the seafloor, as well as different energy loss mechanisms that affect the total hydroacoustic pressure. The effect of the soil stiffness on the wave propagation has been examined and it was observed that the acoustic model gives a fair approximation of the wave propagation for very soft soils.

REFERENCES

Dong, H. & Hovem, J.M. 2011. *Interface Waves, Waves in Fluids and Solid*, Prof. Ruben Pico Vila (Ed.) InTech, Rijeka.

Heitmann, K. Lippert, T. Lippert, S. Ruhnau, M. & von Estorff, O. 2013. On the prediction of pile driving induced underwater sound pressure levels over long ranges. *Proceedings, 20th International Congress on Sound & Vibration, ICSV20,-*. ICSV, Bangkok.

Lippert, S. Lippert, T. Heitmann, K. & Von Estorff, O. 2013. Prediction of underwater noise and far field propagation due to pile driving for offshore wind farms. *Proceedings of Meetings on Acoustics, ICA 2013 Montreal,-*. ICA, Montreal.

Masouleh, S.F. & Fakharian, K. 2007. Application of a continuum numerical model for pile driving analysis and comparison with a real case. *Computers and Geotechnics* **35,** 406-418.

Masoumi, H.R. Degrande, G. & Lombaert, G. 2007. Prediction of free field vibrations due to pile driving using a dy-

namic soil-structure interaction formulation. *Soil Dynamics and Earthquake Engineering* **27,** 126-143.

Milatz, M. Lippert, S. Lippert, T. Von Estorff, O. & Reimann, K. 2012. Prediction of underwater sound due to pile driving for offshore wind farms – a challenge for numerical simulation. *Proceedings, 41st International Congress and Exposition on Noise Control Engineering*, 7939-7950. Inter.noise, New York City.

Müller, A. & Zerbs, C. 2011. *Offshore wind farms measuring instruction for underwater sound monitoring*. Report by BSH, 1-31.

Randolph, M.F. 2003. Science and empiricism in pile foundation design. *Géotechnique* **53,** 847-875.

Reinhall, P.G. & Dahl, P.H. 2011. Underwater Mach wave radiation from impact pile driving: Theory and observation. *Journal of the Acoustic Society of America* **130,** 1209-1216.

Smith, E.A.L. 1960. Pile-driving analysis by the wave equation. *Journal of the Soil Mechanics and Foundations Division* **86,** 35-61.

Tsouvalas, A. & Metrikine, A.V. 2014. A three-dimensional vibroacoustic model for the prediction of underwater noise from offshore pile driving. *Journal of Sound and Vibration* **333,** 2283-2311.

Verruijt, A. 2005. *Soil Dynamics*, Delft University of Technology Zoetermeer.

Zampolli, M. Nijhof, M.J.J. De Jong, C.A.F. Ainslie, M.A. Jansen, E.H.W. & Quesson, B.A.J. 2013. Validation of finite element computations for the quantitative prediction of underwater noise from impact pile driving. *Journal of Acoustic Society of America* **133** (1), 72-81.

Large-size controlled degradation and simple shear testing of municipal solid waste from Michigan

Résistance au cisaillement simple de déchets ménagers (sur grands spécimens) issus du site ou dégradés en simulateur

X. Fei and D. Zekkos

ABSTRACT Waste degradation testing on municipal solid waste from a landfill in Michigan, USA, was conducted and monitored in a laboratory landfill simulator for 1,460 days. Simple shear testing was performed on minimally compacted reconstituted fresh and degraded waste specimens and an "undisturbed" degraded specimen. The shear strength of the fresh waste was found to be 14% higher than the shear strength of the degraded waste. The effective friction angles of the fresh and degraded waste were 22° and 20°, respectively. The shear strength of an "undisturbed" specimen from the simulator was found to be nearly identical to the shear strength of a reconstituted specimen.

1 INTRODUCTION

The shear strength of municipal solid waste (MSW) is critical for the stability of modern subtitle-D landfills. Shear strength estimates are usually based on laboratory testing, with the direct shear testing being the most common (Bray et al. 2009). Triaxial testing has also been executed (Zekkos et al. 2012). Simple shear testing has rarely been conducted except for a few studies (Kavazanjian et al. 1999; Pelkey et al. 2001) despite being a popular test in characterizing the shear strength of soils.

The impact of degradation on the shear strength of MSW remains largely unknown with conflicting results reported (Bareither et al. 2012; Hossain et al. 2003). Mechanisms by which the shear strength of the MSW may increase, reduce or remain the same, can be postulated. MSW degradation takes place at variable rates in modern landfills. Biodegradable waste constituents, including food waste, yard waste and different types of paper, are consumed by microorganisms and eventually converted to biogas which consists primarily of methane (CH_4) and carbon dioxide (CO_2). Thus, the composition and density of MSW changes during degradation.

In this study, a 300 mm-diameter landfill simulator and a 300 mm-diameter simple shear device were used to execute degradation testing and shear testing of waste specimens. Fresh waste specimens were reconstituted in the simple shear device using a waste sample recovered from a landfill in Michigan, USA, to characterize the shear strength of the material at the fresh state. Fresh waste of identical waste composition and density was also reconstituted in the landfill simulator and the degradation process was closely monitored. A fully degraded waste specimen was recovered from the simulator with minimal disturbance and was tested in the simple shear device to assess the change in shear strength of the MSW due to degradation. Additional degraded waste specimens were reconstituted to assess the effect of reconstitution on shear strength and investigate the impact of confining stress on shear strength. The results of this testing program are presented. Due to the heterogeneous nature of the MSW and the large size of its constituents, large-size testing is necessary with 300 mm in diameter considered a reasonably large size (Athanasopoulos et al. 2008). In addition, waste constituents are not modified in size, as this process has been shown to result in a shear response that may not be representative of field conditions.

2 METHODOLOGY

2.1 Characterization of MSW

The MSW used in this study was excavated from Sauk Trail Hills landfill in Michigan, and was transported in sealed drums to the University of Michigan. The composition of the waste sample was characterized according to the procedures described by Zekkos et al. (2010). The waste was first separated into a finer fraction that passed through a 20-mm sieve and a coarser fraction. The coarser fraction was subsequently segregated into primarily paper, soft plastic, and wood. The proportion of each waste constituent of the sample was calculated on a weight basis.

2.2 Degradation testing of MSW

A MSW specimen was reconstituted based on the field waste composition and used for degradation testing. The initial total mass, mass percentage on a wet basis, moisture content, and volatile solids of each waste constituent are shown in Table 1.

Table 1. Total mass, total volume, and total unit weight of simulator specimen, and mass percentage, moisture content and volatile solids of each waste constituent before waste degradation.

Total mass (kg)	Volume (L)	Total unit weight (kN/m^3)	Average moisture content (% w/w dry)	Dry mass (kg)
21.3	36.1	5.8	42.1	15.0

Constituent	Total mass (kg)	Moisture content (w/w dry)	Dry mass (kg)	Volatile solids (w/w dry)
<20 mm	15.8	31.8	12.0	0.235
Paper	3.2	116.3	1.5	0.398
Soft plastic	1.2	68.0	0.7	0.618
Wood	1.1	37.7	0.8	0.514

A 42-L simulator (diameter=300 mm, height=600 mm), accompanied by a system to recirculate and store leachate, and a system to monitor the long-term waste degradation process was constructed (Figure 1a) and is described in more detail in Fei *et al.* (2014). The waste specimen was manually loaded into the simulator with minimal compaction on day 1 and the simulator was operated and monitored for 1,460 days (Fig. 2). The initial volume of the MSW was 36.1 L (initial height, H0 =0.51 m), and the initial total unit weight was 5.8 kN/m3. On day 17, the drainage valve at the bottom of the simulator was closed and deionized water was added to the simulator to completely submerge the specimen. The specimen remained submerged for 15 minutes before the valve was opened and the leachate drained by gravity. The submersion process was repeated three times a week. Thus, the specimen was maintained at field capacity in between saturations accelerating waste degradation (Fei et al. 2014).

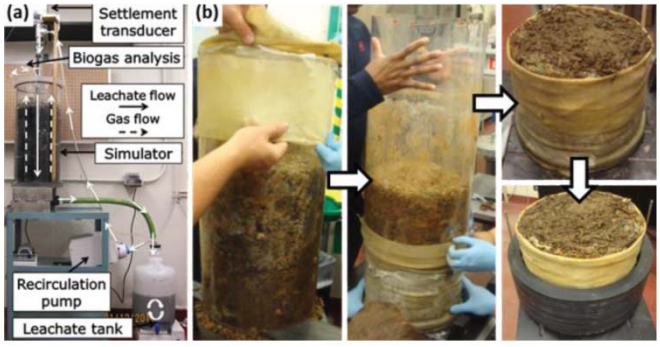

Figure 1. (a) Schematic of the simulator system for MSW degradation testing; and (b) schematic of simulator disassembly and "undisturbed" degraded waste specimen recovery.

Leachate samples were collected one hour after specimen drainage started. A portion of each leachate sample was

centrifuged at 10,000g for 15 minutes and the supernatant was filtered through 0.45 μm nylon membrane filter. The remaining portion of the leachate sample and the filtrate were analyzed for total and soluble chemical oxygen demand (tCOD and sCOD), respectively. Biogas composition was measured by a gas chromatograph equipped with a thermal conductivity detector. Measurement of biogas composition was interrupted on day 390 due to instrumentation problems.

The settlement of the MSW specimen in the simulator was measured continuously by a displacement transducer. The strain of the specimen, as a percentage, was defined as the specimen settlement divided by H_0. On day 400, a weighing scale was placed beneath the simulator and total weight (W_t) measurements were collected at each "saturated" and drained state. Given that the volume of the MSW is always measured, the "saturated" and field capacity unit weight of the specimen were calculated. On day 475, a heating blanket was wrapped around the simulator to increase the temperature of waste to 40±3 °C.

2.3 Disassembly of MSW degradation simulator

The MSW degradation test was stopped after 1,460 days of operation and the simulator was disassembled. Extreme caution was taken to minimize disturbance to the specimen during disassembly. A 300 mm diameter latex membrane was wrapped around the column of the simulator and the Plexiglas column was carefully pulled out. Consequently, the "undisturbed" degraded MSW specimen was contained in the membrane for simple shear testing. The composition of the waste specimen was characterized after shear testing (Table 3).

2.4 Simple shear testing of MSW

A 300mm-diameter simple shear device was used for testing fresh and degraded waste specimens. Reconstituted specimens were prepared by placing the waste in the simple shear device to achieve the target density. Fresh specimens were prepared at 5.8 kN/m^3, which is the total unit weight of the waste in the simulator at the beginning of degradation testing. Degraded specimens were reconstituted so that the specimen's total unit weight upon consolidation is similar to the "undisturbed" specimen's total unit weight prior to shearing. Each specimen was first subjected to one-dimensional compression at a constant vertical stress for 24 hours and then sheared at a constant strain rate of 0.46±0.02 %/min. During shearing, the vertical load is maintained constant, allowing the specimen to compress or dilate. The testing conditions of the simple shear tests presented in this study are tabulated in Table 2.

3 RESULTS AND DISCUSSION

The simulator was operated and monitored for 1,460 days (~4 years) before its disassembly. The long-term monitoring data is presented below, followed by the simple shear test results on fresh and degraded MSW specimens.

3.1 Long-term MSW degradation testing

Photos of the simulator at different times of degradation testing are shown in Figure 2. Settlement (expressed in terms of strain), specimen unit weight at field capacity ($\gamma_{t,fc}$) and at saturation ($\gamma_{t,sat}$), biogas composition, and total and soluble COD in leachate during MSW degradation are plotted in Figure 3.

Long-term settlement of the waste specimen can be divided into three phases (Fei and Zekkos 2013). Immediate compression was observed between days 1 and 10, and is attributed to physical mechanisms such as particle readjustments, softening, and raveling. Active long-term compression took place from day 10 to approximately day 1,000 during which the strain increased roughly linearly with the increase of logarithmic time. An abrupt increase in strain on day 475 is due to the addition of a heating blanket to the simulator and a rise in temperature to 40 °C. Accelerated degradation, change of field capacity moisture content, and thermal expansion of the column and waste specimen must have contributed to the abrupt vertical displacement. Residual compression was observed after day 1,000 during which mechanical creep was the major mechanism. The total strain on day 1,460 was 26.2% (Figure 3a).

Table 2. Vertical stress, unit weight, and testing results of waste specimens.

Specimen ID[1]	σ_v (kPa)	$\gamma_{t,con}$ (kN/m^3)	τ_{max} (kPa)	ϕ (°)
MIF1	47	7.6	17.4	20.5
MIF2	48	8.6	17.2	19.4
MIF3	96	9.4	37.1	20.8
MIF4	196	9.6	82.9	22.8
MIF5	393	11.5	162.5	22.3
MID0	197	12.9	62.9	17.7
MID1	48	11.8	17.2	19.9
MID2	97	13.1	34.3	19.6
MID3	196	14.3	67.9	19.1
MID4	394	16.2	140.8	19.7

σ_v: vertical stress; $\gamma_{t,con}$: unit weight prior to shearing; τ_{max}: peak shear stress.
[1] MIF1 to MIF5: reconstituted fresh specimens;
MID0: undisturbed degraded specimen;
MID1 to MID4: reconstituted degraded specimens.

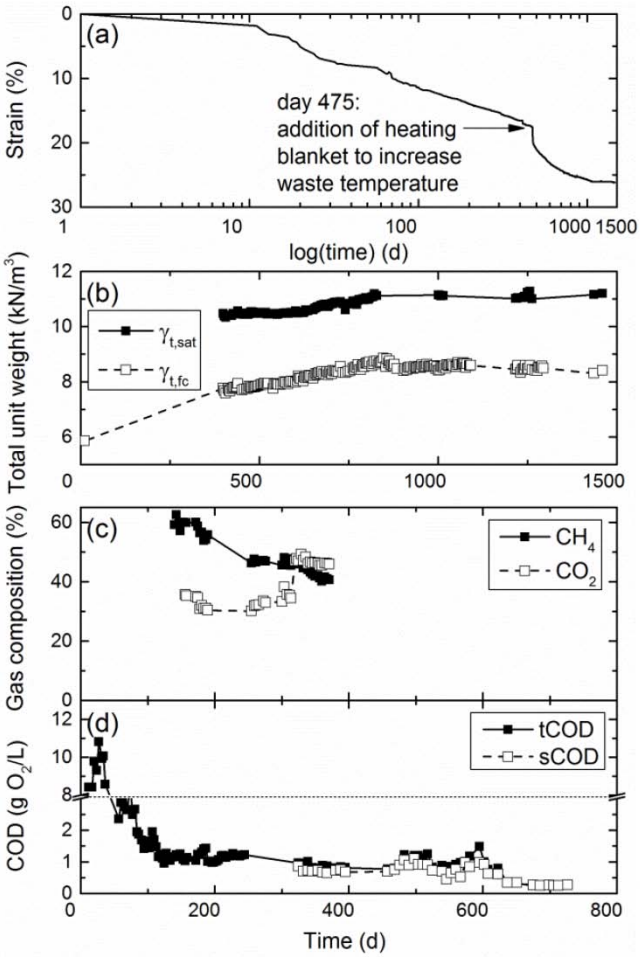

Figure 3. Changes of variables during waste degradation testing: (a) strain; (b) saturated ($\gamma_{t,sat}$) and field capacity ($\gamma_{t,fc}$) total unit weight; (c) biogas composition; and (d) total COD (tCOD) and soluble COD (sCOD) in leachate.

The total unit weight of the specimen upon preparation and at moisture content below field capacity was 5.8 kN/m^3. The $\gamma_{t,fc}$ of the specimen increased to 7.8 kN/m^3 on day 400 after repeated leachate "saturation" and drainage. The $\gamma_{t,fc}$ increased to 8.5 kN/m^3 on day 850 and fluctuated minimally between days 850 and 1,460. The $\gamma_{t,sat}$ of the specimen was 10.5 kN/m^3 on day 400. Similarly, $\gamma_{t,sat}$ gradually increased to 11.1 kN/m^3 on day 850 and remained relatively constant afterward (Figure 3b). The relatively constant values of $\gamma_{t,fc}$ and $\gamma_{t,sat}$ between days 850 and 1,460 suggested that the field capacity moisture content and void ratio of the specimen did not undergo significant change during that period.

The biogas generated during waste degradation primarily consisted of CH_4 and CO_2. Their concentrations were 60% and 36% on day 140, respectively. The concentration of CH_4 decreased from day 200 to 40% on day 380, whereas the concentration of CO_2 increased from 36% to 46% (Figure 3c), as expected during degradation and active methanogenesis .

The tCOD in the leachate was 8.4 g O_2/L after initial saturation of the specimen by deionized water and subsequent drainage. The maximum value of tCOD was measured to be 10.8 g O_2/L on day 27. The value decreased rapidly to 1.1 g O_2/L on day 116, and then decreased to 0.2 g O_2/L by the end of the testing. The sCOD in the leachate was below 1 g O_2/L between days 330 and 730, and was slightly lower than tCOD during the same period (Figure 3d). The changes of tCOD and sCOD in the leachate with time were typical of waste degradation under favorable conditions for microbial activity.

The evolution of settlement, $\gamma_{t,fc}$ and $\gamma_{t,sat}$, biogas composition, and COD in the leachate indicated that waste degradation was largely complete after the simulator was operated for 1,460 days. Therefore the simulator was disassembled and the total mass, and total volume recorded. Following simple shear testing, the mass percentage, moisture content and volatile solids of each waste constituent were measured (Table 3). The moisture content of each waste constituent increased after degradation, whereas the respective volatile solids were similar before and after degradation. The estimated dry mass of <20 mm fraction and paper decreased significantly due to degradation. Since degradation of soft plastics and wood is believed to be minimal, the small reductions in their dry masses were probably due to difficulties in characterization, such as variability in moisture contents.

Table 3. Total mass, total volume, and total unit weight of the specimen, and mass percentage, moisture content and volatile solids of each waste constituent after waste degradation testing.

Total mass (kg)	Volume (L)	Total unit weight (kN/m^3)	Average moisture content (% w/w dry)	Dry mass (kg)
23.0	26.0	8.5	97.2	11.7

Constituent	Total mass (kg)	Moisture content (w/w dry)	Dry mass (kg)	Volatile solids (w/w dry)
<20 mm particle	18.0	55.5	10.1	0.246
Paper	1.2	121.5	0.4	0.395
Soft plastic	2.1	186.8	0.5	0.723
Wood	1.4	71.1	0.7	0.536

3.2 Simple shear testing of MSW specimens

The stress-strain relationships for all simple shear tests are plotted in Figure 4. All of the fresh and degraded waste specimens showed similar stress-strain response with a peak shear resistance reached at large strains. In this study, the shear resistance at 10% shear strain is defined as shear strength, although the shear resistance at larger strains may reach values that are 1.3 times higher.

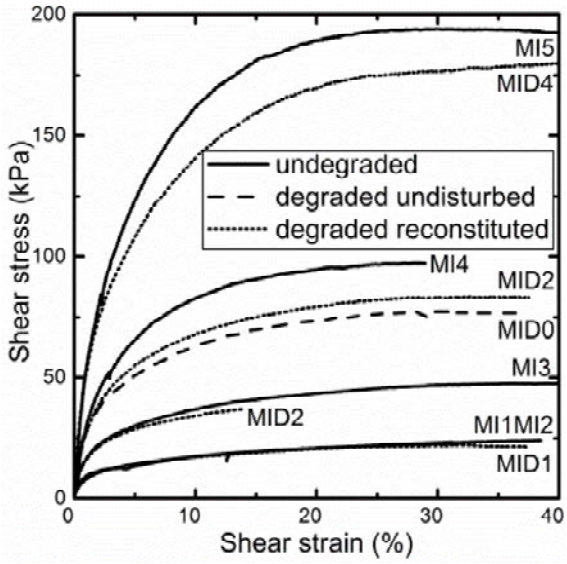

Figure 4. Stress-strain relationships for simple shear tests on fresh and degraded waste specimens.

Interpretation of the simple shear tests in order to derive an estimate of the friction angle is more complex. This is because only a single stress point (σ_v', τ) on the Mohr circle is measured during the test and thus, the Mohr circle and the specimen's stress state is poorly defined. An extensive discussion of these issues has been made by others, particularly DeGroot et al. (1992), and is beyond the scope of this paper.

An assumptions for the failure state of the specimen needs to be made in order to estimate the friction angle of the material. Degroot et al. (1992) discussed seven different assumptions. In this study, it is assumed that the horizontal plane is the failure plane, i.e., the plane of maximum obliquity. In that case, the friction angle of the soil is given by the equation:

$$\varphi = \beta = \tan^{-1}\frac{\tau_{hf}}{\sigma_{vf}'} \quad (1)$$

where τ_{hf} is the measured horizontal shear stress at failure, and σ_{vf}' is the measured vertical effective stress at failure. This assumption is generally considered incorrect for isotropic materials (DeGroot et al. 1992; Roscoe et al. 1967), but is widely used in practice because it yields a low, and thus conservative, friction angle. It may also be more appropriate for MSW due to its anisotropic nature and the observations in the field and laboratory that waste constituents are oriented in the horizontal plane (Zekkos 2013).

The shear strength data of the fresh and degraded MSW specimens are shown in Figure 5. The shear strength of the fresh specimens was 14% higher than that of the degraded specimens. The Mohr-Coulomb envelope is characterized by c=0 and φ=22° for the fresh waste and c=0 and φ=20° for the degraded waste. Note that the as-consolidated total unit weight of the degraded specimens was higher than that of the fresh specimens primarily due to the higher moisture content of the degraded specimens.

The shear strength of the "undisturbed" degraded specimen (62.9 kPa) was 7% lower than that of the reconstituted degraded specimen (67.9 kPa) at a vertical stress of 200 kPa. That difference may be partially attributed to the "undisturbed" specimen's lower unit weight compared to the reconstituted degraded specimen. For practical purposes, this comparison indicates that "undisturbed" and reconsti-

tuted specimens yield approximately the same results, although more data is needed to draw a definitive conclusion (Figure 5).

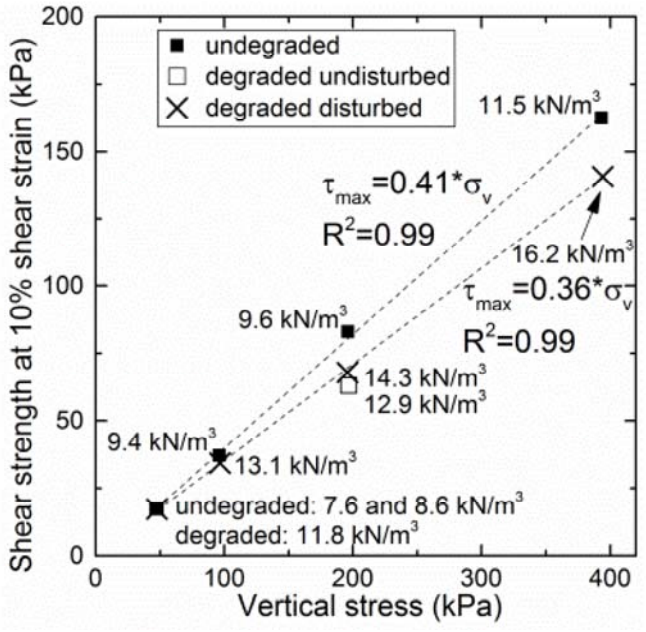

Figure 5. Relationship of vertical stress and shear strength at 10% shear strain for fresh and degraded waste specimens.

4 CONCLUSION

A waste degradation test was conducted and monitored in a simulator for 1,460 days. The waste was fully degraded and its saturated unit weight was found to increase with degradation. Simple shear testing was performed on reconstituted fresh and degraded waste specimens as well as an "undisturbed" degraded specimen. The shear strength of the degraded specimens was found to be 14% lower than the fresh specimens. The shear strengths were generally low, due to the minimal compaction effort during specimen preparation. The effective friction angle of the fresh waste was 22°, whereas the friction angle of the degraded waste was 20°. An "undisturbed" degraded specimen had practically the same shear strength as that of a reconstituted degraded specimen.

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REFERENCES

Athanasopoulos, G.A., Grizi, A., Zekkos, D., Founta, P. & Zisimatou, E. Municipal solid waste as a reinforced soil: Investigation using synthetic waste. *Geocongress 2008: Geotechnics of Waste Management and Remediation*, (Eds: Khire, M. V., Alshawabkeh, A. N. & Reddy, K. R.), 168-175. ASCE.

Bareither, C.A., Benson, C.H. & Edil, T.B. 2012. Effects of Waste Composition and Decomposition on the Shear Strength of Municipal Solid Waste. *Journal of Geotechnical and Geoenvironmental Engineering* **138,** 1161-1174.

Bray, J.D., Zekkos, D., Kavazanjian, E., Jr., Athanasopoulos, G.A. & Riemer, M.F. 2009. Shear Strength of Municipal Solid Waste. *Journal of Geotechnical and Geoenvironmental Engineering* **135,** 709-722.

DeGroot, D.J., Ladd, C.C. & Germaine, J.T. 1992. *Direct simple shear testing of cohesive soils* [Online]. Department of Civil Engineering, Massachusetts Institute of Technology.

Fei, X. & Zekkos, D. 2013. Factors Influencing Long-Term Settlement of Municipal Solid Waste in Laboratory Bioreactor Landfill Simulators. *Journal of Hazardous, Toxic, and Radioactive Waste* **17,** 25-271.

Fei, X., Zekkos, D. & Raskin, L. 2014. An Experimental Setup for Simultaneous Physical, Geotechnical and Biochemical Characterization of Municipal Solid Waste Undergoing Biodegradation in the Laboratory. *ASTM Geotechnical Testing Journal* **37**.

Hossain, M.S., Gabr, M.A. & Barlaz, M.A. 2003. Relationship of compressibility parameters to municipal solid waste decomposition. *Journal of Geotechnical and Geoenvironmental Engineering* **129,** 1151-1158.

Kavazanjian, E., Jr., Matasovic, N. & Bachus, R.C. Large diameter static and cyclic laboratory testing of municipal solid waste. *7th International Waste Management and Landfill Symposium*, (Eds, 437-444.

Pelkey, S.A., Valsangkar, A.J. & Landva, A. 2001. Shear displacement dependent strength of municipal solid waste and its major constituent. *Geotechnical Testing Journal* **24,** 381-390.

Roscoe, K.H., Bassett, R.H. & Cole, E.R.L. Principal axes observed during simple shear of a sand. *Geotechnical Conference*, (Eds, 231-237.

Zekkos, D., Kavazanjian, E., Bray, J.D., Matasovic, N. & Riemer, M.F. 2010. Physical Characterization of Municipal Solid Waste for Geotechnical Purposes. *Journal of Geotechnical and Geoenvironmental Engineering* **136,** 1231-1241.

Zekkos, D., Bray, J.D. & Riemer, M.F. 2012. Drained response of municipal solid waste in large-scale triaxial shear testing. *Waste Management* **32,** 1873-1885.

Zekkos, D. 2013. Experimental evidence of anisotropy in municipal solid waste. *Coupled Phenomena in Environmental Geotechnics.* CRC Press.

Calibrating plane strain models to simulate 3 dimensional arching effect in sprayed concrete lining tunnel

Calibrage de modèles dilatation plane pour simuler en 3 dimensions les effets d'arc dans la doublure béton pulvérisé (SCL) d'un tunnel

K.N. Neaupane, P. Isidorou, S. Modeshia

ABSTRACT Two Dimensional (2D) finite element plane strain models for simulating Sprayed Concrete Lining (SCL) tunnels are evaluated by comparison with axisymmetric and full 3-Dimensional (3D) simulations. Single tunnel geometry fully embedded in London clay is used to calibrate the 2D Finite Element (FE) models to arrive at suitable load factors/relaxation factor that accounts for 3D effects and yields deformation and lining forces similar to those obtained from a 3D model. Case history data from Redcross Way Jubilee line has also been used to calibrate a tunnel constructed with side drift excavation sequence. Time-dependent behaviour of shotcrete lining was considered in both 2D and 3D simulations. It is demonstrated that with suitably chosen load factors, the displacement and lining forces predicted by a 2D plane strain model provides fairly accurate 3D simulations of SCL tunnels.

1. INTRODUCTION

Three dimensional (3D) modelling is computationally demanding and requires significantly higher set up and run time than plane strain models, which in turn results in higher costs and demand on resources. Despite the fact that 3D modelling has become more accessible to designers with technological advances allowing for an increase in computational power, two dimensional (2D) analysis is still widely adopted. Common practice for using 2D modelling of tunnels is where it is assumed that plane strain conditions apply. In three dimensions, the tunnel face provides support. As the tunnel face advances away from the area of interest, the support decreases until the stresses can be accurately modelled with a plane-strain approach. This presents a need to calibrate, validate and compare the 2D methods of simulating the three dimensional redistribution of stress at the face.

In order to model a tunnel in a 2D finite element model and achieve a realistic simulation, one must take into account the 3D effects that occur during tunnelling. As the tunnel excavation advances through soft ground, arching of stresses in the ground occur and therefore deformations at the face are typically less than the maximum deformations at say distance 'x' behind the excavation face. If this 3D arching effect was not simulated in 2D analysis, and the tunnel lining was 'wished in placed', then the calculated ground movements would be under predicted and as a result the lining stresses over predicted. Therefore to model the tunnel without this consideration of the arching of stresses in the ground would give an unrealistic representation of the lining force and ground movement in reality.

To take into account the 3D arching effect and achieve a realistic simulation, the following methods are generally used (Karakus, 2007):

(1) Stress relaxation or convergence confinement method: This method uses an internal pressure applied to the boundary of the tunnel excavation (Panet & Guenot, 1982).

(2) Core replacement method: This method uses the progressive softening of soil in the tunnel as proposed by Swoboda (1979).

(3) Hypothetical Modulus of Elasticity (HME): This method uses predetermined modulus values for the stiffness of the sprayed concrete lining as described by Powell et.al (1997) and Karakus and Fowell (2003) (Figure 1).

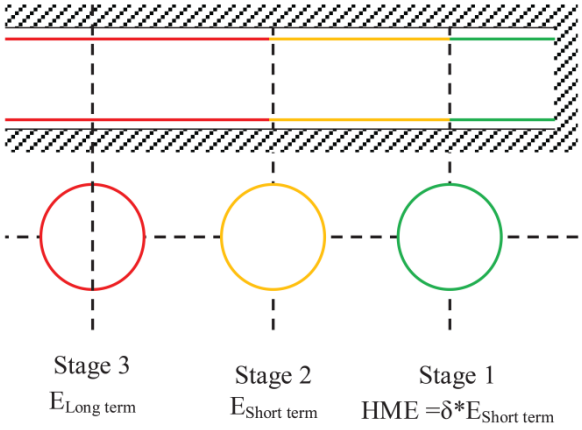

Figure 1 Hypothetical Modulus of Elasticity

The numerical design process using FE analysis involves 4 major steps namely; Observe - develop the conceptual model, Measure - define the theoretical model, Explain – develop the analytic/numerical model, and Verify – Calibrate, validate against the physical reality. The overall design process begins with the calibration of models, followed by prediction of results during design. These data are then measured during construction and used to validate the predicted results. The process involves a constant cycle of determining trigger levels based on design predictions, monitoring / measuring results, and validating this with the design. This is one of the main principles behind SCL and NATM design.

The discussion in this paper is focused on Sprayed Concrete Linings (SCL), the Institution of Civil Engineers recommended name for the lining of tunnels by this construction method in soft ground (ICE, 1996). Three such methods of calibration are discussed in the following sections namely; a full 3D model with staged excavations, case history data from published literature (Redcross Way Jubilee line), and simplified axi-symmetric model. Model calibration process is described based on both ground deformation and lining forces.

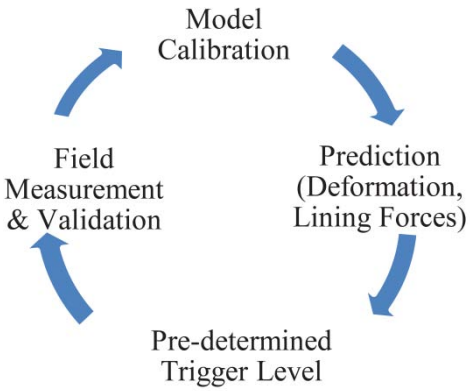

Figure 2 Conceptual Calibration Process

2. THREE DIMENSION (3D) MODEL

A theoretical 3D finite element model was created using Plaxis 3D for which a target surface settlement was determined providing a basis for calibrating the 2D modelling. To simulate the tunnel advances in 2D, Convergence Confinement method was used and evaluations of the 2D modelling were undertaken in terms of volume loss, deformation and lining forces against the 3D model. The calibration process uses the same geometry of the tunnel, lining properties, soil profile, soil parameters, water profile and construction se-

quences. Relaxation factors used in 2D models are adjusted to obtain desired results (deformations and forces).

The geometry of the tunnel and excavation stages are given in Figure 3. The tunnel is approximately 6m in radius, 35m below ground and fully embedded in the London Clay. The construction stage follows: excavation of pilot tunnel (20m) followed by excavation of top heading, benching and invert (ring closure). Pilot tunnel advanced rate is assumed to be 5m/day and complete tunnel advance rate 3m/day (not to include pilot tunnel excavation).

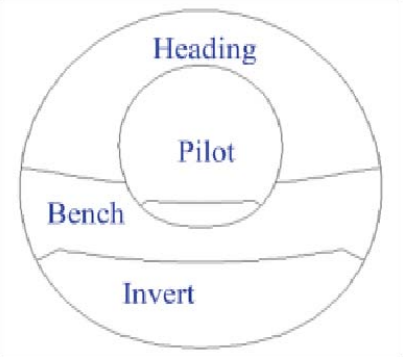

Figure 3 (a) Tunnel Geometry in 2D Plane Strain

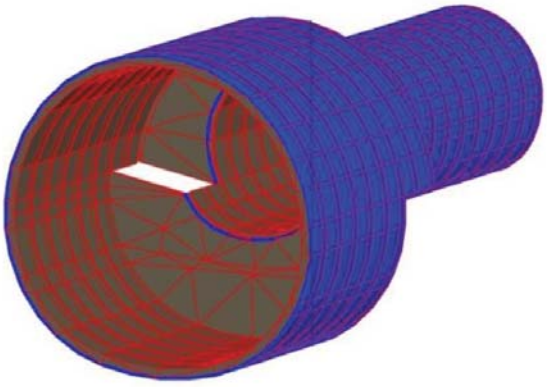

Figure 3 (b) Tunnel Geometry in 3D view

2.1 Geology and Input Parameters

The geological profile at the site of the tunnel was assumed to be the typical London ground condition comprising of Made Ground, Terrace Gravels and London Clay followed by Lambeth Group formation and Thanet Sand. The tunnel has been assumed to be wholly within London Clay as this was considered to be a suitable material for this method of construction, as it is deemed to be fairly homogenous, with low permeability and has a good stand up time with the undrained shear strength of the clay varying with depth between 50–250 kN/m^2.

A Hardening Soil model was used to represent soil constitutive behaviour to describe stress-dependency of soil stiffness moduli reasonably accurately using three different input stiffnesses: the triaxial stiffness E50, the triaxial unloading stiffness E_{ur} and the oedometer loading stiffness E_{oed}. The characteristic soil parameters used in the study are shown in Table 1.

2.2 Undrained Modelling in Plaxis

Plaxis 3D recommends three different methods of modelling undrained soil behaviour. Method A is an undrained effective stress analyses with effective stiffness as well as effective strength parameters. Method B is an undrained effective stress analyses with effective stiffness parameters and undrained strength parameters. Method C is an undrained total stress analyses and ruled out for this analyses. Method A is used in this analysis to model short term behaviour where excess porewater pressure is developed followed by consolidation phase in which excess porewater pressure is dissipated (Plaxis 3D 2013).

Table 1: Input parameters

Material	γ kN/m3	K_o	c' kPa	ϕ' deg	E_{50}^{ref} / E_{oed} kPa	E_{ur} kPa	P_{ref} kPa
Made Ground	20	0.57	0	25	05E3	1.5E3	10
River Terrace	18	0.43	0	35	20E3	60E3	50
London Clay	20	1.20	5	23	40E3	1.2E5	100
Cohesive Lambeth	21	1.20	5	27	50E3	1.5E5	100
Thanet Sand	21	1.00	0	38	2.5E5	7.5E5	550

2.3 Discussion of the Results

In order to assess the 3D effects occurring around the tunnel during construction the 3D model has been interrogated with regard to ground movement. Figure 4 shows the predicted surface settlement from the plane strain and 3D models. The maximum surface settlement from the 3D model fairly accurately matches those from plane strain models. However, the settlement trough from the 3D model is much narrower. This is because in the plane strain analysis using Convergence Confinement method, the effect of pilot tunnel ahead of the enlargement/excavation could not be accounted. During the enlargement excavation, pilot tunnel lining is automatically uninstalled and ground deformation is over-predicted.

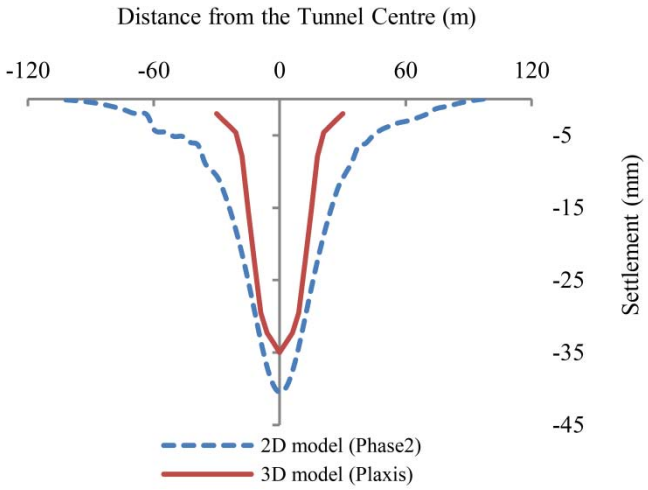

Figure 4 Surface Settlement from plane strain and 3D FE analyses

The hoop thrust in a circular tunnel assuming no soil structure interaction can be calculated simplistically by resolving reactions developed in the lining. Therefore by taking into account full overburden loading ($N = \sigma_v \, . \, r$) where, N is the hoop axial force, σ_v is the vertical stress in the soil and r is the radius of the tunnel. This formula determines that with full overburden loading acting on the tunnel with approximate radius of 6m, a hoop thrust of approximately 4650 kN/m would be generated, not taking into shape effect of the tunnel. It can be seen from Table 2 the results are less than this, therefore indicating that a reduced loading is accounted for in the analysis. This corroborates the ground arching theory and allowance of pre-deformation prior to lining installation.

Table 2: Comparison of Lining Forces

Material	Values	2D Phase^2	3D Plaxis
Pilot Tunnel	Hoop Force (kN)	1008	1530
	Bending Moment (kN m)	29	9
Main Tunnel (7d)	Hoop Force (kN)	2156	2650
	Bending Moment (kN m)	96	90
Main Tunnel (Long-term)	Hoop Force (kN)	2898	3300
	Bending Moment (kN m)	171	170

Table 2 summarises lining forces (Thrust and Bending Moment) from 2D and 3D models. Theoretically where ground movements in the model are greater, the hoop thrust is likely to be smaller. As the deformation in the 2D model is higher, the hoop thrust predicted by 2D is smaller than that predicted from the 3D model. Plane strain analyses underestimates thrust forces in the pilot tunnel as it can not account for overstressing of the pilot tunnel ahead of excavation. This problem may be accounted for if Core Replacement method is used to simulate tunnel excavation. This is however, beyond the scope of this study.

3. CASE HISTORY: REDCROSS WAY TUNNEL

Jubilee Line Extension Redcross Way Tunnel in the London Underground has been taken as the baseline model. The tunnel was extensibly monitored and data published in Kovacevic et al. (1996). The tunnel is located approximately 28m below ground and its diameter is approximately 10m. Figure 5 shows the typical geometry of the section of tunnel with the appropriate excavation stages (Single sidewall drift sequence). The construction sequence has an important influence on the behaviour of SCL tunnels, so all parts of the construction sequence were modelled to make the simulation more realistic. The construction of the trial tunnel consisted of the left-hand drift being constructed to the full length tunnel section (approximately 30m), then the right-hand drift enlargement being excavated subsequently following similar stages as the left-hand drift. Upon completion of the right-drift the removal of the sidewall followed.

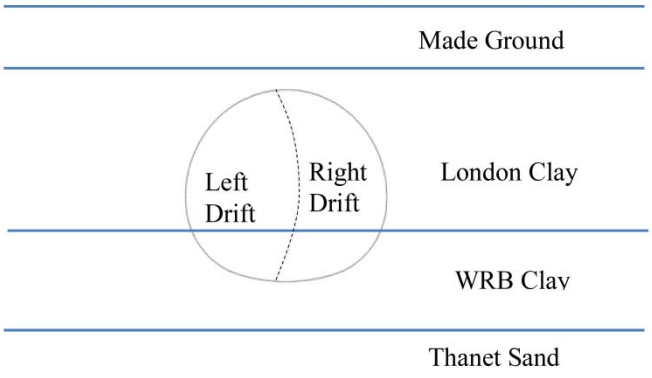

Figure 5 Soil profile and JLE Redcross Way tunnel (not to scale)

3.1 Discussion of the Results

A number of models have initially been created for this calibration using Phase2 commercial software (Rocscience, 2014). Sprayed concrete stiffness varies with age and exhibits significant creep (Thomas 2003). Both of these phenomena were incorporated into the design. The Sprayed Concrete Lining was modelled by one-dimensional linear elastic beam elements. To simulate the increase in stiffness of the sprayed concrete with time, the stiffness is set according to the age of the lining. The concrete stiffness has been divided by a factor of 2.0 to account for creep, in accordance with Eurocode 2. The excavation and lining installation times are taken from the cycle time estimations based on construction programme. The early age properties of SCL lining have been derived from the J2 curve (EN 14487-1:2005 (E)) and Chang and Stille (1993) thereafter.

Stress relaxation method is used to simulate 3D stress redistribution effect by applying fraction of field stress radially outwards holding the ground. As the excavation progresses, the field stress is gradually reduced to zero allowing the lining to take loads. As a start, a numerical simulation was undertaken using three step relaxation (100-50-0%). The factors were varied to match surface settlement and volume loss with the monitored data.

Figure 6 shows predicted surface settlement trough with different combination of relaxation factors. At the Redcross Way trial tunnel, a comprehensive monitoring system was installed to monitor surface and subsurface settlement. Kovacevic et.al (1996) reported maximum surface settlement of approximately 22 mm. The surface settlement predicted with the relaxation steps 100%, 70% ,30 % and 0% is in good agreement with the measured settlement. The predicted trough width of 100m and volume loss of approximately 1% also matches with the measured value.

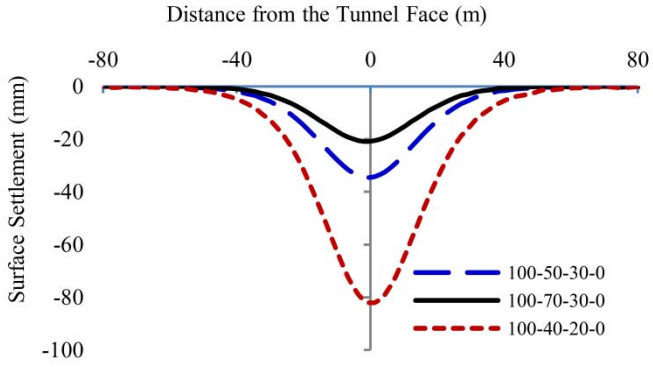

Figure 6 Settlement profile for different relaxation factors

Table 3 presents summary of measured and predicted values of forces. For a comparison, predicted results from published literature (Kovacevic et.al (1996) is included in the table together with the predicted values from this research. Results from this study slightly underestimate the surface settlement and the hoop force in short term. For the model calibration purpose, it is reasonable to assume that the values are in fairly good agreement. The predicted values of hoop force, Bending Moment and Surface Settlement in the long term condition could not be verified as monitoring data were not available.

Table 3: Comparison of Lining Forces

Material	Values	Predicted	Measured	*JLE Predicted
7 days (Ring Closure)	Hoop Force (kN)	2156	2650	1650
	Moment (kN m)	96	90	200-220
Long-term	Hoop Force (kN)	2898	-	-
	Moment (kN m)	171	-	-

* Values taken from Run 2 model (Kovacevic et.al, 1996)

4. AXISYMMETRIC MODEL

2D axisymmetric models can be used to model a 3D excavation which is rotationally symmetric about an axis. In 2D axisymmetric models, all the geometry must lie in the XY plane and loads and displacements must be specified in the same plane. Axi-symmetric models are generally used to simulate end of tunnel / headwall dome. However, it provides opportunity to calibrate 2D models exploiting the rotational symmetry of 3D objects. In this example, Phase2 axisymmetric capabilities are utilised to calibrate circular / near circular tunnel.

Axisymmetric model as shown in Figure 7 represent longitudinal profile of the tunnel projected on horizontal plane. Although the true orientation of an excavation can be arbitrary, for the purposes of the analysis, coordinates are mapped so that the model is symmetric about the X = 0 axis (i.e. a vertical axis located at X = 0), since all finite elements are rotated about this axis. The horizontal forces (σ_x, σ_y) are manually estimated and stress boundary is imposed using field stresses only ignoring the body forces. The model in this study represents a near circular tunnel in London Clay located approximately 40m below ground surface. Excavation is carried out in stages taking 1m slice per stage and assigning the stiffness of the sprayed concrete according to the age of the lining as described before.

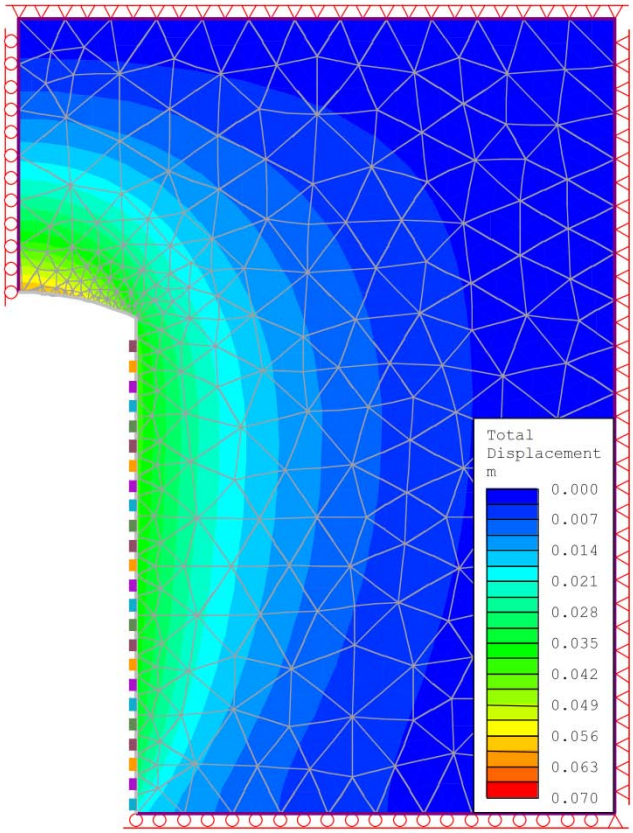

Figure 7: Total deformation around longitudinal profile of tunnel from axisymmetric model

Figure 8 gives variation of hoop axial force along the longitudinal section. As shown in the graph 1m off the tunnel face hoop axial force represents approximately 50% of the full lining load. Ground deformation at the face is 16mm which is half of the far field deformation. This indicates the ground relaxation of 50% at the face.

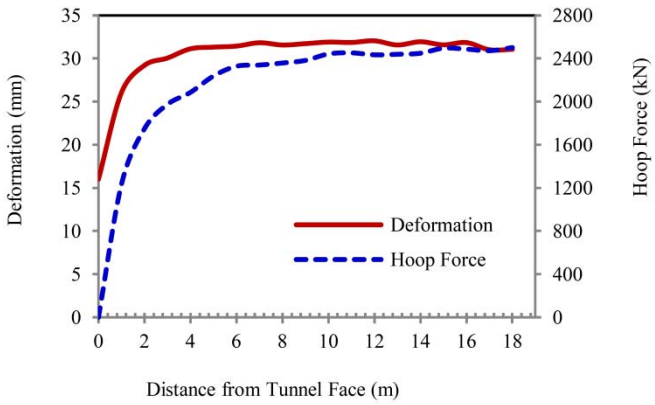

Figure 8: Hoop-axial force from the axisymmetric analyses

5. CONCLUSION

Three methods of calibrating plane strain models have been described, namely 3D modelling, historical data and axi-symmetric analyses. The study presents examples of single tunnel constructed with staged excavation sequence. Stress relaxation to be used for multiple tunnels could be entirely different as ground behaviour would depend upon the proximity of tunnels and construction sequence. Separate calibration is required in such cases. Although deformation monitoring data from past projects are available, data on lining forces are limited and site specific. Axi-symmetric models have their own limitations which leaves the 3D method as a readily available calibration choice. Although the 3D model replicates the realistic construction of the tunnel, it still has its limitation. Deformation (and therefore the forces in the lining) depends on the constitutive soil model. A simple Hardening Soil model was used in this study, which does take into consideration the unloading modulus. However, for accurate ground deformation prediction, more sophisticated small strain stiffness constitutive models such as Hardening Soil small strain, Jardine's model, etc. are required. To ensure the 3D model simulates the realistic ground behaviour it must be validated against field data and as such the most suitable calibration choice is that of historical data. Research and comparisons with field data should be encouraged to create a database for the tunnelling industry.

References

Chang, Y. and Stille, H. (1993). Influence of early-age properties of shotcrete on tunnel construction sequences, *Shotcrete for Underground Support VI*, pp. 110-117.

Eurocode 2, 2004. *Design of concrete structures-Part 1-1: General rules and rules for buildings* (EN 1992-1-1:2004), British Standards Institution, London.

Institution of Civil Engineers 1996. Sprayed Concrete Linings (NATM) for Tunnels in Soft Ground, *an ICE Design and Practice Guide*, Thomas Telford.

Karakus, M. 2007. Appraising the methods accounting for 3D tunnelling effects in 2D plane strain FE analysis. *Tunnelling and Underground Space Technology*, Vol. 22(1): 47-56.

Karakus, M., Fowell, R.J. 2003. Effects of different tunnel face advance excavation on the settlement by FEM. *Tunnelling and Underground Space Technology*, Vol. 18(5), 513-523.

Kovacevic, N., Edmonds, H.E., Mair, R.J., Higgins, K.G. and Potts, D.M. 1996. Numerical modelling of the NATM and compensation grouting at Redcross Way. *Int. Symp. Geotechnical Aspects of Underground Construction in Soft Ground*, City University, London, UK, 553-559.

Panet, M. and Guenot, A. 1982. Analysis of convergence behind the face of a tunnel, *Tunnelling'85*, The Institution of Mining and Metallurgy, London, pp. 197-203

Plaxis 3D 2013. *Reference Manual.* Available from: http://www.plaxis.nl

Powell, D.B., Sigl, O., Beveridge, J. P. 1997. Heathrow-Express design and performance of platform tunnels at Terminal 4, *Tunnelling' 97*, IMM, London.pp.565-593.

Rocscience Inc. 2014. Phase2 v8.0 – Two-dimensional finite element program https://www.rocscience.com

Swoboda, G., 1979. Finite Element analysis of the New Austrian Tunnelling Method (NATM), *Proc. 3rd Int. Conf. Num. Num. Meth*. Geomech., Aachen, 2, pp.581-586.

Thomas A.H. 2003. Numerical Modelling of Sprayed Concrete Lined (SCL) Tunnels PhD thesis, University of Southampton.

ΔΙΑΚΡΙΣΕΙΣ ΕΛΛΗΝΩΝ ΚΑΙ ΦΙΛΩΝ ΓΕΩΤΕΧΝΙΚΩΝ ΜΗΧΑΝΙΚΩΝ

Mair confirmed as next ICE President

ICE Council has officially elected professor Lord Robert Mair as President for ICE's bi-centenary year. He will succeed Tim Broyd on 1 November 2017. As well as working on many international tunnelling and deep excavation projects, Mair was closely involved with the Jubilee Line Extension for London Underground, the Channel Tunnel Rail Link - now HS1 and Crossrail.

In October 2015, he was appointed to the House of Lords as an independent crossbencher. As a crossbencher he can take part in legislative debates free of party considerations.

Διόρθωση

Στο προηγούμενο τεύχος, στην ίδια σελίδα, αναφέρθηκαν σε υποσημείωση οι συντελεστές της μελέτης και κατασκευής της Gold Line του ΜΕΤΡΟ της Doha. Ως μελετητικές εταιρείες αναφέρθηκαν οι ATKINS, ARUP και OTM, αντί του ορθού ATKINS, ARUP και **ΟΚ** (ΟΜΙΚΡΟΝ ΚΑΠΑ ΜΕΛΕΤΗΤΙΚΗ ΑΕ).

ΝΕΑ ΑΠΟ ΕΛΛΗΝΙΚΕΣ ΚΑΙ ΔΙΕΘΝΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΝΩΣΕΙΣ

Video on Fascinating Geotechnical Engineering News in 2016

Geoengineer.org just created a video with some of the most fascinating geotechnical engineering news in 2016. It can be found here: https://youtu.be/eOBwkdB4rU0 I thought you may find it interesting. Best wishes for the new year!

Tunnelling works around the world in 2016

This video presents the major tunnelling works in progress in 2016 as well as some future projects.

https://www.youtube.com/watch?v=NJQlvrJfHP0&feature=share

ΠΡΟΣΕΧΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΚΔΗΛΩΣΕΙΣ

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

MPM 2017 - First international conference on the material point method for Modelling Large Deformation and Soil–Water–Structure Interaction, 10 – 13 January 2017, Delft, The Netherlands, http://mpm2017.eu

International Workshop on "Advances in Multiphysical Testing of Soils and Shales", 18-20 January 2017, Villars, Switzerland, http://atmss.epfl.ch

ICNCGE-2017 International Conference on New Challenges in Geotechnical Engineering, 23 January 2017, Lahore, Pakistan, www.pges-pak.org/home/icncge-2017

2nd "Dams & Seisms" EWG Workshop "Lessons Learned from the Recent Earthquakes in Italy. Qualification of Seismic Dams Analyses and of their Equipments & of Probabilistic. Assessment of Seismic Hazard in Europe", February 6-7, 2017, Roma, Italy, giovanni.ruggeri@enel.com

Tunnelling Asia' 2017 - Design, Construction and Risk Management in Underground Construction : Issues & Challenges, 9 - 10 February, 2017, Mumbai, India, sunil@cbip.org; cbip@cbip.org; www.cbip.or

International Congress and Exhibition HYDROPOWER CASPIAN AND CENTRAL ASIA, 15-16 February 2017, Tbilisi, Georgia, www.hydropowercongress.com

4th Arabian Tunnelling Conference & 20th Gulf Engineering Forum - Advancing Underground Space, 21-22 February 2017, Dubai, UAE, www.atcita.com

AFRICA 2017 - Water Storage and Hydropower Development for Africa, 14-16 March 2017, Marrakech, Morocco, www.hydropower-dams.com/AFRICA-2017.php?c_id=89

3rd Annual Urban Underground Space & Tunnelling, 27th-29th March 2017, Singapore, http://isocarp.org/events/3rd-annual-urban-underground-space-tunneling

International Conference on Advances in Structural and Geotechnical Engineering

27 - 30 March 2017, Hurghada, Egypt
http://icasge.com/conference/307

The conference shall provide a forum for researchers and professionals from various fields related to the theory of structures, soil mechanics and foundation engineering, reinforced concrete constructions, properties and testing of materials, environmental engineering, steel constructions, construction management, etc…, as well as other related areas, to exchange and discuss the latest findings and experiences. The Conference program includes invited keynote lectures, a limited number of oral presentations, and poster presentations.

The topics of interest include but not limited to:

- Analysis, Modeling and Design
- Structural Stability
- Innovative Structural Conservation, Repair and Strengthening
- Soil Improvement
- Problematic Soils
- Underground Constructions
- Soil Dynamics and Earthquake Geotechnical Engineering
- Extending the Life of Structures
- Innovative Construction Materials
- Sustainable and Green Construction Materials
- Durability and Life Prediction of Structures
- Non-destructive Testing Forensic Investigation for Structural Health Monitoring
- Earthquake Engineering
- Active and Semi Active Structural Control
- High performance structures and systems
- Soil Structure Interaction
- Smart Structural Systems
- Construction Planning and Scheduling
- Safety, Quality and Environmental Management
- Risk Analysis and Decision Making

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Instrumentation and Monitoring Conference 2017 - Innovation, best practice and projects, 29- 30 March 2017 | Inmost, London, U.K., https://monitoring.geplus.co.uk

2nd International Conference on Geotechnical Research and Engineering (ICGRE'17), April 3 - 4, 2017, Barcelona, Spain, http://icgre.org

IS - São Paulo 2017, 9th International Symposium on Geotechnical Aspects of Underground Construction in Soft Ground, April 4 and 5 2017, São Paulo, Brazil, www.is-saopaulo.com

Southeast Asian Conference and Exhibition in Tunneling and Underground Space 2017 (SEACETUS 2017) - Innovation and Sustainable Underground Space Development, 18 – 19 April 2017, Subbing Jaya, Selangor, Malaysia, nora@iem.org.my

EURO:TUN 2017 IV International Conference on Computational Methods in Tunneling and Subsurface Engineering, 18 – 20 April 2017, Innsbruck, Austria, www.eurotun2017.com

SEE TUNNEL 2017 Zagreb 7th International Symposium on Tunnels and Underground Structures in South-East Europe, May 4-5, 2017, Zagreb, Croatia, www.promovere.hr

YSRM2017 & NDRMGE 2017 Challenges and Innovations in Rock Mechanics and Engineering, 10-13 May 2017, Juju Island, South Korea, www.ysrm2017.com

TGG-2017

Transportation Geotechnics and Geoecology
17 –19 May, 2017, Saint Petersburg, Russia
http://conf-geotech.wixsite.com/tgg-2017

Nowadays transportation infrastructure faces great challenges due to increasing of operation speed and load and construction in specific conditions.

International scientific conference "Transportation Geotechnics and Geoecology" will be held in Emperor Alexander I Petersburg State Transport University on May 17th – 19th, 2017 to give an up-to-date picture of the field of design, construction and exploitation of transport facilities and to share the latest experience.

We are pleased to invite researchers and practitioners to St.Petersburg, Russia, and look forward to your active participation and feedback.

Main Topics

- modern challenges of railway subgrade and roadbed;
- design, construction and exploitation of high speed railway subgrade;
- heavy-axle load operation problems;
- geophysical techniques for geological survey and diagnostics;
- geotechnical monitoring in transport facilities construction maintenance;
- disaster prevention in geotechnical structures;
- stability of slopes, landslides, debris flows and avalanches;
- soil dynamics and earthquake engineering;
- geotechnical modelling of transport facilities base;
- use of geosynthetics in construction and reconstruction of transport facilities;
- techniques of earth foundation strengthening;
- geotechnical problems in permafrost regions;
- noise and vibration protection;
- geoenvironmental technologies in construction and reconstruction of transport facilities;
- bearing capacity and uneven settlement of ballast under repeated passage of trains;
- cracking of pavement caused by the natural influences and due to repeated cars passages;
- geotechnical monitoring of underground infrastructure during construction and exploitation;
- transport facilities influence on underground structures;
- geotechnical problems of underground construction in complex geotechnical conditions;
- modern technologies used for the reinforcing of the foundations and construction of underground infrastructure;
- theoretical basis of transportation geoecology;
- geoecoprotective materials, structures and constructures for transportation;
- evaluation methods of natural and man-made transportation systems geoecoprotection.

Contact organizing committee geotech@pgups.ru

TechnoHeritage 2017 3rd International Congress Science and Technology for the Conservation of Cultural Heritage, May 20-23, 2017, Cádiz, Spain, http://technoheritage2017.uca.es

EPS'17 5th International Conference on the Use of EPS Geofoam Blocks in Construction Applications, 22-24 May 2017, Istanbul, Turkey, www.geofoam2017.org

First JTC1 Workshop on
Advances in Landslide Understanding
24-26 May 2017, Barcelona, Spain
http://congress.cimne.com/jtc1/frontal/default.asp

The Joint Technical Committee on Natural Slopes and Landslides (JTC1) of the International Society for Soil Mechanics and Geotechnical Engineering, the International Society for Rock Mechanics and the International Association for Engineering Geology is delighted to invite you to join us at the First **JTC1 Workshop on Advances in Landslide Understanding** to be held in **Barcelona, Spain** in **May 24th - 26th, 2017**.

The aim of the Workshop is to promote discussion between scientists and engineers on topics which require attention because of difficulties in identification, triggering causes, mechanisms, modelling and prevention, such as:

- Brittle failures/ First time failures
- Transition slow-fast motion
- Stability of weathered profiles
- Compound landslides
- Landslides in reservoirs
- Landslides in mines and tailing deposits
- Soil - atmosphere interaction

Scientific Secretary

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4th World Landslide Forum "Landslide Research and Risk Reduction for Advancing Culture of Living with Natural Hazards", May 29 – June 2, 2017, Ljubljana, Slovenia www.wlf4.org

Rapid Excavation and Tunneling Conference, June 4-7, 2017, San Diego, USA, www.retc.org

IV International Course on Geotechnical and Structural Monitoring, June 2017, Rome, Italy, www.geotechnicalmonitoring.com/en

PRF 2017 Progressive Rock Failure, 5-9 June 2017, Ascona, Switzerland, www.prf2017.ethz.ch

EAgs - EurAsian Geotextiles Symposium 2017, 07 - 08 June 2017, Beijing, China, www.edana.org/education-events/conferences-and-symposia/event-detail/eurasia-geotextiles-symposium-2017

World Tunnel Congress 2017 Surface challenges – Underground solutions, 9 to 16 June 2017, Bergen, Norway, www.wtc2017.no

EUROCK 2017 Human Activity in Rock Masses, 20-22 June 2017, Ostrava, Czech Republic, www.eurock2017.com

BCRRA 2017 Tenth International Conference on the Bearing Capacity of Roads, Railways and Airfields, 28th to 30th June 2017, Athens, Greece, www.bcrra2017.com

85th Annual Meeting of International Commission on Large Dams, July 3-7, 2017, Prague, Czech Republic, www.icold2017.cz

6th International Conference on Coupled THMC Processes in Geostystems, 5-7 July 2017, Paris, France, https://geoproc2017.sciencesconf.org

2nd International Symposium on Coastal and Offshore Geotechnics (ISCOG 2017) & 2nd International Conference on Geo-Energy and Geo-Environment (GeGe2017)

5-7 July 2017, Zhejiang University, China

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TRANSOILCOLD2017
The 3rd International Symposium on Transportation Soil Engineering in Cold Regions

5 -7 July 2017, Guide City, China

http://transoilcold2017.applinzi.com/index.php

Cold regions cover 50% of the world's total land area. All transportation infrastructures in cold regions face great technical challenges due to ground freeze-thaw or permafrost degradation. New transportation infrastructure on embankments, such as high-speed railways on slab tracks or highways, requires high geometry standards. In China, the Qinghai-Tibet Railway has been in operation for ten years but now faces issues due to permafrost degradation. Challenging technical problems will likely arise as more transportation infrastructure, such as high speed railways (HSR) and highways, is being planned and/or constructed in Northwest and Northeastern China, Russia as well as the North America.

The 1st International Symposium on Transportation Soil Engineering in Cold Regions was held in 2013 and offered a unique platform to foster knowledge sharing and experience exchanging for the prevention of problems related to cold region subgrade soils and foundation impacting transportation facilities such as railways and highways.

The 2nd International Symposium on Transportation Soil Engineering in Cold Regions was subsequently held in 2015 in Siberian State University of Railway Engineering, over 200 researchers from 12 countries shared their new achievements in cold regions transportation soil engineering and had a fantastic time in a cruiser on the Obe river.

We are pleased to invite you to Guide, Qinghai, China, where the 3rd International Symposium on Transportation Soil Engineering in Cold Regions (TRANSOILCOLD2017) will be held on July 6-7, 2017. The TRANSOILCOLD2017 aims to provide an opportunity for researchers and practitioners in the transportation community to share the latest research advances and experiences in the construction of transportation infrastructure in cold regions.

We welcome you to Guide, China and look forward to your active participation in the 3rdTranSoilCold Symposium.

Main Topics including but not limited to the cold regions aspects of:

- Mechanical behavior of soil and aggregate
- Non-destructive testing of subgrade and aggregate
- Coupled modeling of mechanical and physical processes
- Frost heave and thaw weakening of subgrade, ballasted subgrade and base of slab track
- Field experiments in roadway embankments
- Long-term monitoring of subgrade functionality
- Dynamic/seismic behavior of transportation infrastructure

- Soil-structure interaction related to transportation infrastructure
- Experience in the construction and maintenance of subgrade in cold region
- Artificial Ground Freezing in transportation
- Other related topics related to transportation soil engineering in cold regions

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10th World Congress on Water Resources and Environment "Panta Rhei", 5-9 July 2017, Athens, Greece, http://ewra2017.ewra.net

GeoMEast2017, 15 - 19 July 2017, Sharm El-Sheik, Egypt, www.geomeast2017.org

3rd International Conference on Performance-based Design in Earthquake Geotechnical Engineering (PBD-III), July 16 - 19, 2017, Vancouver, Canada, http://pbdiiivancouver.com

ICTUS17 The 2017 International Conference on Tunnels and Underground Spaces, 28 August 2017 - 1 September 2017, Seoul, Korea, www.i-asem.org/new_conf/asem17.htm

International Symposium on Coupled Phenomena in Environmental Geotechnics
6-8 September 2017, Leeds, United Kingdom
http://tinyurl.com/cpeg2017

We are delighted to invite you to the second 'International Symposium on Coupled Phenomena in Environmental Geotechnics (CPEG2)' that will be held at the University of Leeds on Wednesday 6 – Thursday 7 September 2017.

CPEG2 follows on from the very successful first CPEG held in Torino (Italy) in 2013. Like CPEG1, CPEG2 is being organised under the auspices of the International Society for Soil Mechanics and Geotechnical Engineering TC215 (Environmental Geotechnics), and CPEG2 will be hosted in conjunction with the British Geotechnical Association.

The symposium will be followed by a "Grand Challenges" workshop on Friday 8 September 2017.

Symposium Themes

Coupled Processes

- Improved understanding of the coupling of any natural and/or anthropogenic thermohydro-mechanical-chemical-bio-gas processes within soils and rocks
- Biogeochemical processes for improving or stabilizing soils
- Multi-phase flow

Surface Containment

- Waste characterization
- Landfill liners and environmental barriers
- Gas generation and extraction
- Waste degradation and settlement
- Capping systems for landfills and polluted sites
- Mine and mineral extraction wastes

Subsurface Containment

- Waste characterization
- Radioactive waste disposal
- Carbon capture and storage

Clean-up

- Novel procedures for the characterization of contaminated sites
- Pollutant retardation and degradation processes
- Active barriers for polluted sites
- Bioremediation / bio-management of metals and radionuclides
- Natural attenuation and enhanced bioremediation of organic pollutants
- Contaminant extraction from polluted soil

Energy (to be coordinated by TC308)

- Thermal properties of soils and rocks
- Energy geostructures
- Shale gas exploitation

Vegetation

- Role of vegetation in sustainable management of slopes and geostructures
- Vegetation controls on urban flooding
- Geotechnics of the soil critical zone: creation or restoration of full soil functionality

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T: +44 (0)113 343 8104 / 2494

19th International Conference on Soil Mechanics and Geotechnical Engineering, 17 - 22 September 2017, Seoul, Korea, www.icsmge2017.org

AfriRock 2017, 1st African Regional Rock Mechanics Symposium, 2 – 7 October 2017, Cape Town, South Africa, www.saimm.co.za/saimm-events/upcoming-events/afrirock-2017

Geotechnique Symposium in Print 2017 Tunnelling in the Urban Environment, http://www.icevirtuallibrary.com/pb-assets/Call%20for%20Papers/Geo-Symposium-CFA-AW.pdf

HYDRO 2017 Shaping the Future of Hydropower, 9-11 October 2017, Seville, Spain, hydro2017@hydropower-dams.com

GeoAfrica 2017 3rd African Regional Conference on Geosynthetics, 9 – 13 October 2017, Morocco, http://geoafrica2017.com

3ο Πανελλήνιο Συνέδριο Φραγμάτων και Ταμιευτήρων - Διαχείριση Έργων και Προοπτικές Ανάπτυξης, 12 - 14 Οκτωβρίου 2017, Αθήνα, www.fragmata2017.gr

4th International Conference on Long-Term Behaviour and Environmentally Friendly Rehabilitation Technologies of Dams
17-19 October 2017, Tehran, Iran
www.ltbd2017.ir/en

For the safe operation of hydraulic structures like earth, rockfill and concrete dams as well as for novel reinforced soil structures, the interaction of the construction with ground settlements, earthquake activities and flooding, the chemical reaction with water, overtopping and the state of weathering and aging of the construction material may play an important role. A further aspect is the rehabilitation and heightening of dams. Another new challenge for engineers is the use of alternative materials for building and repairing dams such as construction waste and mine tailings. In order to take into account the complex interaction of different factors of influence, the relevant aspects must be treated in an appropriate way by the corresponding disciplines, i.e. a multilateral co-operation is needed between the disciplines of Material Technology, Mechanics of Materials, Structural Analysis, Geotechnics and Hydraulic Structures and Environmental Engineering. To this end it is necessary to enforce and extend the international contacts, to build a network and to present and discuss the latest developments in joint conferences and workshops.

The series of international conferences and workshops on "Long-term Behaviour of Dams (LTBD)" was initiated based on scientific and technical cooperation between universities in Asia and Europe and also supported by local governments. It is the aim of these events to provide a forum for engineers, high level scientists, government officials, construction equipment and material manufacturers, operators and young PhD students to present and exchange the latest developments and case histories related to long term behaviour of dams.

The main subtopics of the "International Conference on Long-term Behaviour of Dams" are divided into the following five areas:

- Methods of Design and Analysis of Earth, Rockfill and Concrete Dams
- Properties of Construction Materials for Dams and their Constitutive Modelling
- Seismic Aspects and Earthquake Analysis
- Dam Monitoring, Instrumentation and Safety Assessment
- Maintenance, Heightening and Environmental-friendly Rehabilitation

The first international LTBD conference with the topic "Time Effects and Seepage Behavior of Dams (LTESBD08)" was held 2008 at Hohai University, Nanjing, China. In the same year a LTBD workshop based on a project co-operation between Austria and China was also organized at Tsinghua University, Beijing, China. The second international conference on "Long Term Behaviour of Dams (LTBD09)" was held in 2009 at Graz University of Technology, Graz, Austria. In 2015 an international workshop called "Long-Term Behavior and Environmentally Friendly Rehabilitation Technologies of Dams (LTBD2015)" was held again at Hohai University, Nanjing, China. The fourth International conference in series on "Long-Term Behaviour and Environmentally Friendly Rehabilitation Technologies of Dams (LTBD 2017)" will take place in Tehran, Iran, from October 17 to 19, 2017 and we are confident that this event will also be very successful.

As the President of Iranian Committee on Large Dams (IRCOLD), I am so delighted to welcome all participants of the 4th International Conference on Long-Term Behavior and Environmentally Friendly Rehabilitation Technologies of Dams (LTBD 2017) on October 17-19, to Tehran, Iran. This is an excellent opportunity for Iran to be the host of this international scientific event and we are happy to have distinguished scientists, engineers and other professionals involved in the dam industry here in Tehran.

Conference will start with pre-study tours and technical sessions and will be followed by workshops and post-study tours. The workshops will provide an international forum for the academics from universities and institutes and practicing engineers from private and public firms to present and discuss their up-to-date reviews of recent accomplishments and the future trends in the field of dam engineering.

I believe that LTBD 2017 conference will have an impact on the development of dam engineering, and will also provide a forum for discussion, sharing knowledge and experiences, innovative ideas, research results and will foster collaboration amongst the participants.

Conference Topics

- Methods of Analysis and Design of Earth, Rockfill and Concrete Dams including Experimental, Analytical and Numerical Investigations
- Time-Dependent Properties of Construction Materials for Dams and Their Constitutive Modeling
- Seepage Under Saturated and Unsaturated Conditions
- Interaction of Dam Foundation Structure
- Seismic Aspects and Earthquake Analysis
- Dam-Monitoring, Instrumentation and Safety Assessment
- Operation, Maintenance, Rehabilitation and Heightening
- Long Term Behaviour of Dams with Respect to Loading History and Climate
- Environmental Issues

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The 15th International Conference of International Association for Computer Methods and Advances in Geomechanics
18- 22 October 2017, Wuhan, Hubei Province, China
www.15iacmag.org

It is my greatest pleasure to invite you to attend the 15th International Conference of the International Association for Computer Methods and Advances in Geomechanics (15th IACMAG) on October 19-23, 2017 in Wuhan, China.

The 15th IACMAG aims to provide a forum for exchanging new experiences and discussing future developments of computer methods in Geomechanics and geotechnical engineering and other important and related topics like constitutive modeling and wide applications. The main theme is "Advance of Computer Methods in Geomechanics" to emphasize the critical role of computer methods in meeting geotechnical engineering requirements for development and the need to protect and preserve our environment. The conference will cover the entire scope of computer methods and current research topics in Geomechanics and geotechnical engineering. In addition to the 4-day technical program, we will also organize technical visits, exhibitions, social programs, and programs for accompanying persons. Pre-conference workshops and short courses will also be organized.

Conference Topics

- Advances in Computer Methods
- Rock and Soil Mechanics
- Constitutive Models
- Testing and Modeling
- Coupled T-H-M-C Processes in Geosystems: Fundamentals, Modeling and Experience
- Mining Engineering and Dam Engineering
- Tunnels, Caverns and Slopes in Hazardous Geo-environments
- Shale Gas Extraction
- Underground Storage of Petroleum, Gas, CO_2, and Nuclear Waste Disposal
- Environmental Geotechnology
- Offshore and Marine Technology
- Geothermal Energy
- Ice Mechanics
- Earthquake and Dynamics
- Geomaterials
- Other Related Topics

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ISAUG 2017

2nd International Symposium on Asia Urban GeoEngineering
24-27 November 2017, Changsha, China
www.isaug2017.org

You are warmly invited to attend the 2nd International Symposium on Asia Urban GeoEngineering on November 24-27, 2017 in Changsha, a historical and modern city in Hunan, China. The aim of this symposium is to share ideas and experiences about urban geoengineering in Asian countries among engineers, researchers and academia professors. The emphasis will be on improving our knowledge in meeting geoengineering requirements for a long-term sustainable urban development and the need to protect and preserve our environment. We look forward to having the pleasure of welcoming you all in Changsha.

Extensively urban construction is going on in Asian countries, environmental friendliness and sustainability are emphasized in modern urbanization processes. Environmental friendliness addresses the control of ground movement, mitigation measures and risk management. Those control or mitigation measures should be sustainable. Moreover, the performance of deep excavation and tunnels, mitigation measures and risk management are often site dependent and vary from country to country. The ground conditions, construction practices, codes and standards are very different among Asian countries. The aim of this symposium is to share knowledge and experiences of the analysis, design, construction and maintenance of urban geoengineering among engineers, researchers and academia professors in Asian countries.

Symposium theme

Environmental friendliness, sustainability and diversity in urban geoengineering

Topics

- Fundamental behavior and constitutive model of geomaterials;
- Excavation engineering;
- Tunneling;
- Urban environmental geotechnical problems and disaster effects;
- Risk and safety assessment, management and control in urban geoengineering;
- Design standards of deep excavation among Asian countries

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XIII International Conference "Underground Infrastructure of Urban Areas 2017", 24-26 October 2017, Wroclaw, Poland, http://uiua.pwr.edu.pl/?lang=en

SIFRMEG 2017 Shaoxing International Forum on Rock Mechanics and Engineering Geology, October 28-29, 2017, http://forum.hmkj.com.cn/index.php/Index/show/tid/20

PARIS 2017 AFTES International Congress "The value is Underground", 13-16 November 2017, Paris, France, www.aftes2017.com

World Tunnel Congress 2018 "The Role of Underground Space in Future Sustainable Cities", 20-26 April 2018, Dubai, United Arab Emirates, www.wtc2018.ae

EUROCK 2018
22-26 May 2018, Saint Petersburg, Russia

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

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

9th European Conference on Numerical Methods in Geotechnical Engineering
25-27 June 2018, Porto, Portugal

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

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

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

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

CHALK 2018

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

The British Geotechnical Association (BGA) with support from the Engineering Group of the Geological Society (EGGS) will be hosting a major two-day international conference on Engineering in Chalk on 17th and 18th September 2018 at Imperial College in London.

The last major conference on Chalk was held almost 30 years ago in 1989 in Brighton. Since that time, considerable work has been undertaken internationally through research and in many major projects in Chalk, advancing our understanding of its origin, nature and engineering behavior. The 2018 conference therefore seeks to bring together the knowledge and experience gained in the last three decades by presenting research and case histories to provide a definitive up to date perspective on a wide range of Technical Themes relating to engineering in Chalk.

It is planned that the conference will include a technical exhibition, a conference and technical tours.

Technical Themes

Case histories of construction and engineering in Chalk

This Technical Theme includes case histories of construction and engineering in Chalk and assesses the impact of adverse geological conditions and the measures/procedures adopted in order to mitigate them.

Earthworks in Chalk

This Technical Theme includes the assessment of Chalk material characteristics in the laboratory and in-situ, its performance characteristics in handling and placing, and it's performance (both short and long term) in cut slopes, fill embankments, in road and rail sub-grades, and in deep foundations.

Foundations and piling in Chalk

This Technical Theme includes aspects of foundations, retaining walls and piles in Chalk.

Future engineering issues in Chalk

This Technical Theme includes innovation and future issues for engineering in chalk. Possible subjects include digital and technological innovation (investigation, testing, construction, monitoring, modelling and design); issues of climate change (challenges, risks and opportunities); future issues of interface between engineering and Chalk natural resources (landscape, coastline, rivers, groundwater, habi-

tats); issues of aging infrastructure on and in the Chalk; issues of knowledge transfer and legacy.

Geological hazards in Chalk

This Technical Theme aims to cover the measures taken to identify chalk hazards (e.g. hazard assessment techniques, investigation strategies) and provide engineering solutions (remedial & mitigation measures, also construction impacts). The types of geological hazard might include: naturally formed cavities (solution features), drift filled hollows, periglacial features, faulting, man-made cavities (mines, quarries, tunnels and others), unstable inland and coastal slopes (natural, man-made). Understanding the mechanisms of ground movement and their trigger is also of interest.

Offshore engineering in Chalk

This Technical Theme addresses aspects of Chalk geology and engineering related to offshore structures.

Site investigation/characterization in Chalk

This Technical Theme covers the desk studies, walkover surveys and investigations required to gather data for design and construction. It includes identification of information sources, site walkover and engineering geomorphological mapping, development of ground models, selection and deployment of appropriate investigation techniques, mass and material description and logging, design of appropriate testing regimes and presentation of data.

Testing in Chalk – in situ and laboratory

The laboratory and in situ testing Technical Theme aims to promote better understanding of the behaviour of Chalk under various conditions, either from samples or directly on the rock mass. Topics in this theme include the determination of engineering properties of Chalk, failure mechanisms, fracture propagation, transport mechanisms and permeability evolution, rock-fluid interactions and in situ stress determination.

Tunnelling in Chalk

This Technical Theme includes the design and construction of shaft, adits and tunnels (sprayed concrete lining, segmental lining tunnels etc) and associated research in Chalk. Possible subjects include factors influencing construction methods and equipment selection, geotechnical design parameters and design methods used, face stability considerations, details of temporary and permanent linings, ground treatment (for example grouting to reduce ground water flows), instrumentation data from tunnelling works, settlement data and any mitigation works.

Water and the environment

This Technical Theme includes hydrogeological and contaminated land aspects of Chalk. Possible subjects include groundwater resources, construction dewatering, ground source heating and cooling and contaminated land investigation and remediation.

The conference organizing committee can be contacted at conference@chalk2018.org.

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

7 ICEGE 2019

International Conference on Earthquake Geotechnical Engineering
17 - 20 June 2019, Rome, Italy

Organizer: TC203 and AGI (Italian Geotechnical Society)
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ISDCG 2019

7th International Symposium on Deformation Characteristics of Geomaterials
26 - 28 June 2019, Glasgow, Scotland, UK,

The Technical Committee 101 of the ISSMEG is pleased to announce the organisation of the 7th International Symposium on Deformation Characteristics of Geomaterials (ISDCG) in 2019, in Glasgow, UK. The symposium is co-organised by the University of Strathclyde in Glasgow, the University of Bristol, and the Imperial College in London.

Building on the success of the previous Symposia organised in Sapporo (Japan) Japan in 1994, Torino (Italy) in 1999, Lyon (France) in 2003, Atlanta (US) in 2008, Seoul (Korea) in 2011 and Buenos Aires (Argentina) in 2015, the 7th ISDCG will equally follow both its traditions and active promotion of new technical elements to maintain it as one of the most popular and vibrant events within the geotechnical community. The technical core themes will focus on: (i) advanced laboratory geotechnical testing; (ii) application of advanced laboratory testing in research, site characterisation, and ground modelling; (iii) application of advanced testing to practical geotechnical engineering. In addition to these traditional topics, sub-themes will include cutting-edge techniques and approaches, for example experimental micro-mechanics, non-invasive monitoring systems, nano and micro-sensors, new sensing technologies. A key goal is to engage with the full spectrum of geotechnical specialists, from early career engineers and researchers through to world leading experts.

14th ISRM International Congress
20-27 September 2019, Foz de Iguaçu, Brazil

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

The theme of the conference embraces all aspects of geotechnical engineering. Geotechnical engineering is the foundation of current as well as future societies, which both rely on complex civil engineering infrastructures, and call for mitigation of potential geodangers posing threat to these. Geotechnical means and solutions are required to ensure infrastructure safety and sustainable development. Those means are rooted in past experiences enhanced by research and technology of today.

At great events such as the European Geotechnical Conference we should: Spread our knowledge and experience to our colleagues; Introduce innovations, research and development of techniques and equipment; Report on successful geotechnical constructions and application of geotechnical design methods, as well as, on mitigation and assessment of geohazards and more.

Such events also provide an opportunity to draw the attention of others outside the field of geotechnical engineering to the importance of what we are doing, particularly to those who, directly or indirectly, rely on our services, knowledge and experience. Investment in quality geotechnical work is required for successful and safe design, construction and operation of any infrastructure. Geotechnical engineering is the key to a safe and sustainable infrastructure and of importance for the society, economy and the environment. This must be emphasized and reported upon.

XVI Asian Regional Conference on Soil Mechanics and Geotechnical Engineering
21 - 25 October 2019, Taipei, China

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

Technical program

1A – Transportation geotechnics.
1B – In situ testing.
1C – Geo-engineering for energy and sustainability.
1D – Numerical modelling in geotechnics.
1E – Foundations & ground improvement.
1F – Unsaturated soils.
1G – Embankments, dams and tailings.
1H – Excavations and tunnels.
1I – Geo-Risks.

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

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ΕΝΔΙΑΦΕΡΟΝΤΑ ΓΕΩΤΕΧΝΙΚΑ ΝΕΑ

World's hottest borehole nearly complete

Geologists say they are close to creating the hottest borehole in the world.

They are drilling into the heart of a volcano in the south-west of Iceland.

They have told the BBC that they should reach 5km down, where temperatures are expected to exceed 500C (932F), in the next couple of weeks.

The researchers want to bring steam from the deep well back up to the surface to provide an important source of energy.

"We hope that this will open new doors for the geothermal industry globally to step into an era of more production," said Asgeir Margeirsson, CEO of the Iceland Deep Drilling Project (IDDP), a collaboration between scientists, industry and the Icelandic government.

"That's the aim - that's the hope. We have never been this deep before, we have never been into rock this hot before, but we are optimistic."

The project is located on the Reykjanes peninsula, where a volcano last erupted 700 years ago.

A huge rig stands out against the black lava fields; inside a drill has been operating for 24 hours a day since August.

It has now descended nearly 4,500m, and the team expects it to hit its target depth of 5km by the end of the year.

Gudmundur Omar Fridleifsson, from Icelandic energy company HS Orka, is the project's chief geologist.

Steam from the deep well could provide an important source of energy

He shows me thin cores of black basalt rock that have been collected from deep beneath the ground.

"It's getting hotter - and that's what we want," he said.

"We don't expect to drill into magma, but we are drilling into hot rock. And by hot rock, we mean 400 to 500C."

Close to the rig, sulphurous steam is blasting from the ground, blending into the grey sky above.

Iceland, sitting on the boundary between two major tectonic plates, is one of the most volcanically active places in the world.

Harnessing this energy through geothermal technology is already well established here.

"In this area at Reykjanes, we typically drill to 2km or 3km depth to harness the steam, to run power plants and produce clean, renewable electricity," explained Asgeir Margeirsson.

"We want to see if the resources go deeper than that."

When the drill gets to 5km, the team expects to find molten rock mixed with water. But with the extreme heat and immense pressure found at this depth, the water becomes what is known as "supercritical steam".

It is neither a liquid nor a gas, but it holds far more energy than either. And it is this supercritical steam that the team wants to bring back up to the surface to convert into electricity.

Geologists collect thin cores of black basalt rock from deep underground

They believe its special properties mean it could produce up to 10 times as much energy as the steam from conventional geothermal wells.

Mr Margeirsson said: "If this works, in the future we would need to drill fewer wells to produce the same amount of energy, meaning we would touch less surface, which means less environmental impact and hopefully lower costs.

"But that is if this works. This is full-scale research and development - we don't know what the outcome will be."

And there is a good reason to be cautious. With volcanoes, expect the unexpected.

In 2009, the IDDP team attempted to drill deep down into another volcanic site. But at 2,100m, they accidentally hit a shallow reservoir of magma.

Footage on the internet shows black smoke billowing from the well - and the drill was destroyed. So is it really a good idea to tamper with these complex and destructive forces of nature?

Simon Redfern, professor of mineral physics at the University of Cambridge, told the BBC: "I think the risks are rather minor. The likelihood is that there will be natural eruptions before any that are generated by human activity."

If the effort works, it might mean fewer wells will need to be drilled to produce the same amount of energy

If the drill does hit magma, because it is under pressure, it would be likely to come to the surface rapidly, he explained.

"It would come out rather like lancing a boil or popping a spot. It would cause huge problems for the drilling operation itself, but it is unlikely to cause anything more significant than that."

Despite Iceland having more than 300 volcanoes, Prof Freysteinn Sigmundsson, a volcanologist at the University of Iceland, says there is still much to learn about them.

"We have many models of what the interior of a volcano looks like, but actually most of these models of active volcanoes are based on indirect observations," he explained.

"We can see seismic waves pass through them, or we can do some geophysical exploration, or we can study ground deformation.

"But actually, we have very few in situ measurements of what the interior of a volcano looks like."

This drilling project, however, would give geologists a unique vantage point, he said.

"There is always some risk... but there is also a risk if we don't do projects like this.

"By this project I think we can really make fundamental discoveries about how volcanoes work, and learn about their properties and conditions - and when magma could erupt to the surface."

The IDDP team says it is currently "drilling blind", which means no rocky debris is coming back up to the surface. Instead, it is somehow being absorbed into the surrounding rocks.

And without being able to examine the rock, it means the geologists really are heading into the unknown.

However, with only a few hundred metres to go, they are optimistic that the world's hottest borehole is now within their sights.

The IDDP project is funded by the International Continental Scientific Drilling Program (ICDP), the National Science Foundation in the US, EU Horizon 2020, as well as energy companies (including HS Orka, Statoil, Landsvirkjun, Orkuveita Reykjavíkur and Orkustofnun) and the Icelandic government.

(Rebecca Morelle / Science Correspondent, BBC News, Iceland, 14 December 2016,
http://www.bbc.com/news/science-environment-38296251)

Ολοκληρώθηκε η κατασκευή της υποθαλάσσιας σήραγγας του Βοσπόρου

https://www.youtube.com/watch? v=8zI2hco-PpA

Η σήραγγα, που βρίσκεται κάτω από τη θάλασσα του Βοσπόρου, θα ενώνει το ασιατικό με το ευρωπαϊκό τμήμα της Κωνσταντινούπολης.

Αναδείχθηκε -μαζί με το δικό μας Κέντρο Πολιτισμού Σταύρος Νιάρχος- ως μία από τις καλύτερες κατασκευές για το 2016 . Πλέον ήρθε η στιγμή να παραδοθεί και σε χρήση, αλλάζοντας τη ζωή εκατομμυρίων ανθρώπων.

Ο λόγος για την υποθαλάσσια σήραγγα, **Eurasia Tunnel**, που εγκαινιάστηκε την Τρίτη από τον Ταγίπ Ερντογάν και παραδίδεται σε κυκλοφορία σήμερα Πέμπτη 22 Δεκεμβρίου.

Η σήραγγα έχει συνολικό μήκος 14,6 χιλιομέτρων και καλύπτει ένα κομμάτι που έχει αυξημένη κίνηση, από το Καζλίτσεσμε της ευρωπαϊκής πλευράς της Πόλης μέχρι το Γκιόζτεπε της ασιατικής.

Θα μειώσει το χρόνο κάλυψης σε 15 λεπτά από τα 100 που χρειάζονται τώρα για να διανύσει κανείς την απόσταση αυτή. Τα 5,4 χιλιόμετρα της σήραγγας, που έχει σχεδιαστεί να αντέχει σεισμούς των 9 βαθμών της κλίμακας Ρίχτερ, είναι κάτω από τη θάλασσα.

Το πιο βαθύ σημείο είναι στα 106 μέτρα κάτω από την επιφάνεια της θάλασσας. Το όριο ταχύτητας στη σήραγγα έχει οριστεί στα 70 χλμ την ώρα. Απαγορεύεται η διέλευση φορτηγών και οχημάτων ύψους πάνω από 2,8 μ.

Το τούνελ παρακολουθείται με κάμερες και ηλεκτρονικά μέσα για ασφάλεια και παραβάσεις.

Η σήραγγα αρχικά θα λειτουργεί για 14 ώρες την ημέρα και σταδιακά μέχρι τις 30 Ιανουαρίου του 2017 θα αρχίσει να λειτουργεί σε εικοσιτετράωρη βάση. Αναμένεται να εξυπηρετεί καθημερινά 1.290 έως και 130 χιλιάδες διερχόμενα αυτοκίνητα.

Το κράτος έχει εγγυηθεί στο σχήμα που ανέλαβε την ανέγερση και εκμετάλλευση για 24 χρόνια, τη διέλευση τουλάχιστον 68.500 οχημάτων ημερησίως. Για το έργο δαπανήθηκαν 1,2 δισεκατομμύρια δολάρια.

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΣΕΙΣΜΟΙ

Μεταξύ Σαντορίνης και Αμοργού «Βρέθηκε» το ρήγμα του σεισμού που σάρωσε το Αιγαίο το 1956

Ο βυθός γύρω από τη Σαντορίνη είναι άκρως ενεργός γεωλογικά

Έλληνες και ξένοι επιστήμονες, οι οποίοι μελέτησαν το υποθαλάσσιο ανάγλυφο μεταξύ Σαντορίνης-Αμοργού, πιστεύουν ότι πιθανότατα αποκάλυψαν το ρήγμα που συνδέεται με τον καταστροφικό σεισμό των 7,5 ρίχτερ του 1956, ο οποίος έπληξε τη Σαντορίνη, την Αμοργό και άλλα νησιά του Αιγαίου, ενώ προκάλεσε και τσουνάμι.

Το συμπέρασμά των ερευνητών -σε συνδυασμό και με την ανάλυση των σεισμικών δεδομένων- είναι ότι «η πιθανότητα νέων σεισμών, υποθαλάσσιας ηφαιστειακής έκρηξης (από το ηφαίστειο Κολούμπος) και συνοδών παλιρροϊκών κυμάτων στην περιοχή Σαντορίνης-Αμοργού είναι σημαντική».

Ο υποθαλάσσιος χώρος ανάμεσα στην Αμοργό και στη Σαντορίνη αποτελεί έναν από τους ενεργότερους χώρους στο Αιγαίο Πέλαγος, όπου κυριαρχούν η ηφαιστειότητα (το υποθαλάσσιο ηφαίστειο του Κολούμπου) και τα ενεργά ρήγματα που προκαλούν καταστροφικούς σεισμούς.

Το 1956 σημειώθηκε ένας από τους μεγαλύτερους σεισμούς του 20ού αιώνα, που ισοπέδωσε σχεδόν τη Σαντορίνη και προκάλεσε παλιρροϊκό κύμα ύψους έως 20 μέτρων, ενώ σκοτώθηκαν 53 άτομα. Το επίκεντρο του σεισμού, αλλά και τα αίτιά που προκάλεσαν το παλιρροϊκό κύμα, συνεχίζουν να απασχολούν πολλούς ξένους και Έλληνες επιστήμονες.

Στο πλαίσιο του διεθνούς πειράματος PROTEUS (Plumbing Reservoirs Of The Earth Under Santorini), που πραγματοποίησαν Έλληνες, Αμερικανοί και Βρετανοί επιστήμονες, με χρηματοδότηση από το Εθνικό Ίδρυμα Επιστημών (NSF) των ΗΠΑ, για πρώτη φορά μελετήθηκε εντατικά ο υποθαλάσσιος χώρος Αμοργού-Σαντορίνης. Τα νέα στοιχεία προήλθαν από υποθαλάσσιες βαθυμετρικές και σεισμικές έρευνες υψηλής τεχνολογίας που έκανε κατά την περίοδο Νοεμβρίου-Δεκεμβρίου 2015 το αμερικανικό ερευνητικό σκάφος «Marcus Langseth» στο βυθό της Σαντορίνης, καθώς επίσης προς τα δυτικά και τα ανατολικά του νησιού.

Από ελληνικής πλευράς, στον ωκεανογραφικό πλου συμμετείχαν η επίκουρη καθηγήτρια του Τμήματος Γεωλογίας και Γεωπεριβάλλοντος του Πανεπιστημίου Αθηνών (ΕΚΠΑ) Παρασκευή Νομικού, η οποία παρουσίασε τα βαθυμετρικά και τεκτονικά δεδομένα σε ημερίδα στο Εθνικό Ίδρυμα Ερευνών την προηγούμενη εβδομάδα. Σχετικά επιστημονικά άρθρα έχουν επίσης υποβληθεί προς δημοσίευση στα διεθνή περιοδικά γεωεπιστημών Tectonophysics και Earth and Planetary Science Letters, που δείχνουν με ακρίβεια το ρήγμα που προκάλεσε το σεισμό, καθώς και πόσο μετατοπίστηκε ακριβώς ο πυθμένας.

Όπως ανέφερε, «στόχος του σεισμικού πειράματος PROTEUS ήταν η χαρτογράφηση του μαγματικού θαλάμου του ηφαιστειακού συγκροτήματος της Σαντορίνης και του Κολούμπου, με τη χρήση χερσαίων και υποθαλάσσιων σεισμογράφων. Επιπλέον, η λεπτομερής ανάλυση των βαθυμετρικών δεδομένων που συλλέχθηκαν, αποκάλυψε τα ενεργά ρήγματα που κυριαρχούν νότια της Αμοργού, ενώ χαρτογραφήθηκαν επίσης και δύο κύριες κατολισθήσεις».

Η κ. Νομικού επισήμανε ότι «η ενεργή ηφαιστειακή δραστηριότητα στα ανατολικά της Σαντορίνης εντοπίζεται μόνο στο υποθαλάσσιο ηφαίστειο του Κολούμπου, οριοθετημένο μέσα στη λεκάνη της Ανύδρου, το οποίο δεν συνδέεται με τα ρήγματα της λεκάνης της Αμοργού και δεν ενεργοποιήθηκε κατά το σεισμό του 1956».

Εξάλλου, στη λεκάνη των Χριστιανών ανακαλύφθηκε για πρώτη φορά ένα υποθαλάσσιο όρος που ονομάσθηκε Proteus (Πρωτέας), ύψους 300 μέτρων, καθώς και ένας κοντινός ηφαιστειακός δόμος καλυμμένος με ιζήματα. Οι ερευνητές εκτιμούν ότι πιθανώς πρόκειται για παλαιότερες ηφαιστειακές δομές που σχηματίστηκαν κατά μήκος του ελληνικού ηφαιστειακού τόξου μεταξύ Σαντορίνης και Μήλου.

Γύρω από το νησί της Σαντορίνης, διαπιστώθηκε επίσης ότι η μορφολογία του υποθαλάσσιου πυθμένα έχει διαμορφωθεί από πολλαπλές ηφαιστειακές κατολισθήσεις αλλά και την απόθεση πυροκλαστικών ροών σε μορφή υποθαλάσσιων αναβαθμίδων, από την καταστροφική έκρηξη του ηφαιστείου της Σαντορίνης πριν από περίπου 3.600 χρόνια.

Εξάλλου, χρησιμοποιώντας ένα δίκτυο ελληνικών και γερμανικών επίγειων σεισμογράφων, κυρίως όμως τα στοιχεία από τις έρευνες υψηλής τεχνολογίας που έκανε πέρυσι στο βυθό της Σαντορίνης το αμερικανικό ερευνητικό σκάφος «Marcus Langseth», για πρώτη φορά επιχειρήθηκε η τρισδιάστατη σεισμική απεικόνιση του μαγματικού θαλάμου του ημιβυθισμένου ηφαιστείου, έτσι ώστε να προσδιορισθεί ο όγκος, η γεωμετρία και οι μετακινήσεις του.

Οι πληροφορίες αυτές είναι σημαντικές, προκειμένου να εκτιμηθεί ο μελλοντικός κίνδυνος έκρηξης του ηφαιστείου. Μέχρι σήμερα είχαν γίνει ελάχιστες μελέτες σεισμικής απεικόνισης στη Σαντορίνη και καμία για το θάλαμο του μάγματος κάτω από το ηφαίστειο. Η σεισμική απεικόνιση έφθασε σε βάθος έως δέκα χιλιομέτρων κάτω από αυτό.

Η έρευνα διευκολύνθηκε, επειδή ο φλοιός κάτω από το βυθό της Σαντορίνη είναι σχετικά λεπτός, πράγμα που καθιστά πιο εύκολη τη σεισμική έρευνα του μαγματικού συστήματος κάτω από το ηφαίστειο.

Τα πρώτα αποτελέσματα του PROTEUS πρόκειται να ανακοινώσουν την Τρίτη ο οι επιστήμονες στο διεθνές συνέδριο της Αμερικανικής Γεωφυσικής Ένωσης (AGU) στο Σαν Φρανσίσκο, ενώ αναμένονται στο μέλλον αναλυτικότερα στοιχεία σε σχέση με το μάγμα κάτω από το ηφαίστειο.

(Newsroom ΔΟΛ, με πληροφορίες από ΑΠΕ-ΜΠΕ, 12 Δεκ. 2016, http://news.in.gr/science-technology/article/?aid=1500120476&ref=newsletter)

'Tiny earthquakes' help scientists predict mountain rock falls

Two of the six limestone block samples used in University of Sussex's Permafrost Lab were from the north face of Zugspitze (the highest mountain in Germany). Credit: Technical University of Munich

The risk of mountain rock falls in regions with sub-zero temperatures, such as the Swiss Alps and parts of Canada, could be better predicted by using technology which measures 'tiny earthquakes' - according to a group of international experts.

In a new study led by the University of Sussex, geoscientists from the British Geological Survey and the Technical University of Munich reveal that using a micro-seismic technique, which detects tiny earthquakes which cause cracks in the rock, alongside modern electrical imaging technology, which measures rock mass, would provide scientists with much earlier warnings of potential rock falls.

Traditionally scientists use a manual method to monitor rock freezing and thawing, which involves drilling holes into rocks and is affected by frost weathering. During the new study the scientists replicated the conditions of a freezing environment in the Permafrost Laboratory at the University of Sussex and monitored the freeze-thaw of six hard and soft limestone blocks during an experiment that simulated 27 years of natural freezing and thawing.

By using the micro-seismic technique together with capacitive resistivity imaging, which measures freezing and thawing in limestone without having to drill into the rock, the study team recorded a staggering 1000 micro-cracking events.

With previous studies showing that higher temperatures, caused by global warming, have led to more unstable mountain rocks - the scientists, who took part in the new study, believe that using the two monitoring techniques together could prove vital for thousands of skiers and mountain climbers who undertake trips every year.

Professor Julian Murton, from the University of Sussex, who led on the study, said: "As our climate warms mountain rock walls are becoming more unstable - so working out how to predict rock falls could prove crucial in areas where people go climbing and skiing.

"Understanding the impact of freezing and thawing on bedrock is vital if we are to assess the stability of mountain rock walls. By using these two techniques together we have not only identified a practical method which allows us to monitor many more cracking events - but also one which can be used for many years to come."

Dr Oliver Kuras, from the British Geological Survey, who led on the development of geo-electrical imaging technology, said: "It is traditionally difficult to reliably 'see inside rock walls' using conventional electrical imaging methods, particularly when repeating surveys over time.

"With our new capacitive resistivity imaging technology, we have extended the advantages of state-of-the-art geo-electrical monitoring to hard rock environments, which should benefit geohazards research in the future."

Professor Michael Krautblatter, from the Technical University of Munich, added: "With this study we could virtually visualise and listen to the cracking of rocks and we can now better understand how rock slopes become unstable and produce hazardous rock falls."

(PhysOrg.com, December 19, 2016, http://phys.org/news/2016-12-tiny-earthquakes-scientists-mountain-falls.html)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΠΕΡΙΒΑΛΛΟΝ

Βαθιά σε ορυχείο του Καναδά, το αρχαιότερο νερό της Γης

Το νερό αναβλύζει από το δάπεδο του ορυχείου σε βάθος 3 χιλιομέτρων (Πηγή: Πανεπιστήμιο του Τορόντο)

Η τελευταία φορά που είδε το φως του ήλιου πρέπει να ήταν πριν καν εμφανιστούν στη Γη πολυκύτταροι οργανισμοί: ερευνητές που εργάζονται σε ένα από τα βαθύτερα ορυχεία του κόσμου υποστηρίζουν ότι ανακάλυψαν το αρχαιότερο νερό του πλανήτη, παγιδευμένο στο υπέδαφος εδώ και 2 δισεκατομμύρια χρόνια.

Τρία χιλιόμετρα κάτω από το επίπεδο του εδάφους, το αρχαιότερο γνωστό νερό αναβλύζει από τα πετρώματα με ρυθμό αρκετών λίτρων ανά λεπτό, αναφέρουν ερευνητές του Πανεπιστημίου του Τορόντο.

Η αρχέγονη πηγή ανακαλύφθηκε στο Κιντ Μάιν, ένα ορυχείο χαλκού, κασσίτερου και αργύρου κοντά στο Οντάριο. Από το ίδιο ορυχείο, το οποίο συνεχίζει να επεκτείνεται, είχε βρεθεί το 2013 ο προηγούμενος κάτοχος του ρεκόρ, νερό ηλικίας τουλάχιστον 1,5 δισ. ετών.

Η νέα ανακάλυψη πηγαίνει πίσω στο χρόνο κατά τουλάχιστον 500 εκατομμύρια χρόνια. Η ηλικία του εκτιμήθηκε με βάση χημικές αναλύσεις σε διαλυμένα αέρια όπως το ήλιο και το αργό.

Μικρόβια δεν βρέθηκαν στα δείγματα, ωστόσο οι ερευνητές επισημαίνουν ότι το νερό περιέχει θειικά ιόντα από χημικές αντιδράσεις που θα μπορούσαν δυνητικά να αξιοποιηθούν ως πηγή ενέργειας από μικροβιακές μορφές ζωής.

Η ανακάλυψη μικροβιακών κοινοτήτων που ζουν βαθιά στο υπέδαφος, απομονωμένες από την υπόλοιπη βιόσφαιρα, θα έδινε μια εικόνα για παρόμοιες μορφές ζωής στον Άρη ή άλλους πλανήτες, λένε οι ερευνητές.

Η ανακάλυψη παρουσιάστηκε την περασμένη εβδομάδα στο συνέδριο της Αμερικανικής Γεωφυσικής Εταιρείας στο Σαν Φρανσίσκο.

(Newsroom ΔΟΛ, 18 Δεκ. 2016, http://news.in.gr/science-technology/article/?aid=1500121601&ref=newsletter)

B24B-05: New Frontiers for Deep Fluids and Geobiology Research in the World's Oldest Rocks

Barbara Sherwood Lollar, Long Li, Boswell A Wing, Oliver Warr, Cheyenne Sunset Sica, Garnet S. Lollar, N.C. Sutcliffe, Jon Telling, Chris J Ballentine, Thomas Giunta. Jill M. McDermott

Discovery of new environmental systems that facilitate investigation of biodiversity, microbial metabolism, life's adaptation to extreme conditions, and limits to life, have expanded our conception of Earth's habitability and informed search strategies for life elsewhere in the solar system. While chemolithotrophic microbial ecosystems in the marine biosphere have been investigated for decades, the geobiology of terrestrial systems is undergoing a recent expansion, in particular to include the > 70% of the continental lithosphere comprised of Precambrian rocks - the oldest rocks on Earth.

Underground research laboratories and mines worldwide provide access to the deep subsurface in Precambrian settings, and targets for investigation of extant microbial ecosystems. Kidd Creek Mine located in Tmmins Ontario on the Canadian Shield is an iconic site. Investigation of fracture fluids here to 3 km revealed H2 production via radiolysis and serpentinization [1]; production of methane and higher hydrocarbons via abiotic organic synthesis [2]; and fracture fluids with mean residence times on the order of a billion years [3]. Recently, investigation of the sulfur cycle in these fluids has revealed a mass independent sulfur isotope signature in the dissolved sulfate, whereby oxidants from radiolysis oxidize Archean sulfide minerals, providing a mechanism to supply both electron donors (H2) and electron acceptors (sulfate) that could fuel a deep microbial biosphere [4]. Recent MPNs results demonstrate the presence of sulfate-reducing bacteria in these waters in the present day. Beginning in 2016 the deep levels at this site are providing access to international teams of researchers to collaborate with the University of Toronto in a multi-year program to characterize the deep CHONS cycles, as terrestrial geobiology continues to expand our understanding of the habitability of the Earth.

[1] Sherwood Lollar et al. (2014) *Nature* **516,**379-382.

[2] Sherwood Lollar et al. (2002) *Nature* **416,**522-524.

[3] Holland et al. (2013) *Nature* **497,**357-360.

[4] Li et al. (2016) *Nature Communications* in press.

(American Geophysical Unin Fall Meeting, San Francisco 12-16 December 2016, Tuesday, 13 December 2016, https://agu.confex.com/agu/fm16/meetingapp.cgi/Paper/162783)

This underground tunnel for cars could cut an hour-long commute down to 15 minutes

Like many cities, London has a serious problem with gridlock. According to Eurostat's Urban Europe report, the city has the worst congestion in Europe — an average commuter there spends 101 hours in traffic every year.

An obvious solution to this problem would be to upgrade or expand the existing tube, train, and bus networks to be more efficient and far-reaching, so that more locals use

mass transit. But PLP Architecture, a London-based firm, is proposing a more radical idea: moving vehicles underground.

A rendering of the CarTube.

Called the CarTube, the firm's concept envisions an underground tunnel of automated, conveyor belt-like tracks. Cars in the tubes would travel a steady speed of 50 mph, so there wouldn't be stop-and-go traffic, PLP's director of research, Lars Hesselgren, tells Business Insider. That would allow the network to cut down commute times by up to 75%.

PLP wouldn't disclose an estimate for the CarTube's cost, but said it could be built at a fraction of the price of Crossrail, a new high-capacity, 73-mile (117 km) railway that's under construction in London and the southeastern UK. That project received £14.8 billion ($15.7 billion) in funding.

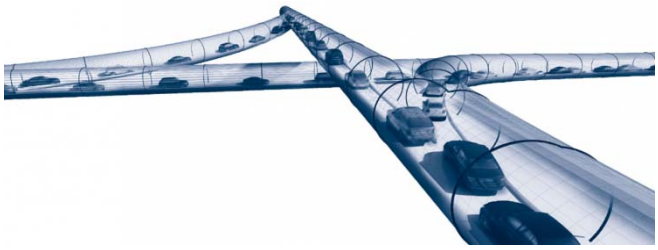
There are no immediate plans to build the CarTube, but Hesselgren says the firm is talking with a number of partners, including Google, about the concept. He estimates that if the tube were to be built, construction would take less than a decade.

The CarTube tunnels would connect to the existing streets. Drivers would just drive onto the tracks, which would slope down to bring them into the tunnel.

The system could accommodate 400 cars per hour, he says.

The CarTube would be a 15.5-mile network of tunnels for automobiles, in which each car would be spaced between .6 and 1.2 miles (1-2 km) apart. Hesselgren says the system would be located 33 to 98 feet (10- 30 meters) below ground level to reduce congestion.

Since the automated tracks would carry riders at a uniform speed, the CarTube could cut down an hour commute to nearly 15 minutes, Hesselgren says. In their proposal, the architects call it "the next best thing to teleportation."



While the team would like to pilot the CarTube in London, they believe it could also be used in other cities that suffer from gridlock, like Shanghai ...

... and New York. Putting cars underground would also free up more street space for pedestrians, Hesselgren says.

While the idea of underground auto tunnels is intriguing and futuristic, however, investing more heavily in the existing tube and bus systems would likely require less time, money, and energy than building a new piece of infrastructure.

As the Guardian also notes, it's unclear where enough underground space could be found in London amidst the tube tunnels, train tunnels, and sewer systems.

But Hesselgren argues that the CarTube would be quicker and more efficient than the metro. "This technology therefore seems worth investigating since it opens new opportunity for not only faster but vastly more convenient sys-

tem," he says. "Extra capacity will certainly be needed by London in the future."

(Leanna Garfield / BUSINESS INSIDER FRANCE, 15 Dec 2016, http://www.businessinsider.fr/uk/cartube-tunnel-for-cars-design-2016-12)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΛΟΙΠΑ

Στην κυκλοφορία η μεγαλύτερη κρεμαστή γέφυρα του κόσμου

Στην κυκλοφορία για τα οχήματα δόθηκε η μεγαλύτερη κρεμαστή γέφυρα του κόσμου, στη νοτιοδυτική Κίνα, σύμφωνα με το Euronews.

Πρόκειται για τη γέφυρα «Beipanjiang», μήκους 1.341 μέτρων, η οποία στέκεται σε ύψος 565 μέτρων πάνω από το έδαφος.

Η γέφυρα ενώνει τις επαρχίες Γκουϊτζόου και Γιουνάν, ενώ πια η απόσταση ανάμεσα στις πόλεις Λιουπανσούι και Χουανουέι θα καλύπτεται εντός περίπου δύο ωρών, αντί για τις πέντε που απαιτούνταν μέχρι σήμερα.

Το κόστος κατασκευής της γέφυρας άγγιξε τα 134 εκατομμύρια ευρώ.

Με την ένωση των δύο άκρων της τον Σεπτέμβριο, η «Beipanjiang» έγινε η μεγαλύτερη κρεμαστή γέφυρα του πλανήτη, αφήνοντας στη δεύτερη θέση τη γέφυρα «Si Du», η οποία στέκεται σε ύψος περίπου 500 μέτρων πάνω από το έδαφος, στην επαρχία Χουμπέι, στην κεντρική Κίνα.

Ενδιαφέροντα Φυσικά Φαινόμενα (Μέρος 1ο)

1. Η Πύλη της Κολάσεως

Ονομάζεται Νταρβάζα ή αλλιώς πύλη της κολάσεως . Πρόκειται για έναν γιγάντιο κρατήρα στην έρημο Καρακούμ, στο Τουρκμενιστάν, ο οποίος δημιουργήθηκε από γεωλόγους που μελετούσαν την περιοχή πριν το 1971. Η φωτιά ξέσπασε λόγο λάθους των ερευνητών, μια πυρκαγιά σε ένα ορυχείο φυσικού αερίου ακόμα δεν έχει υποχωρήσει.

2. Καταιγίδες Λάσπης

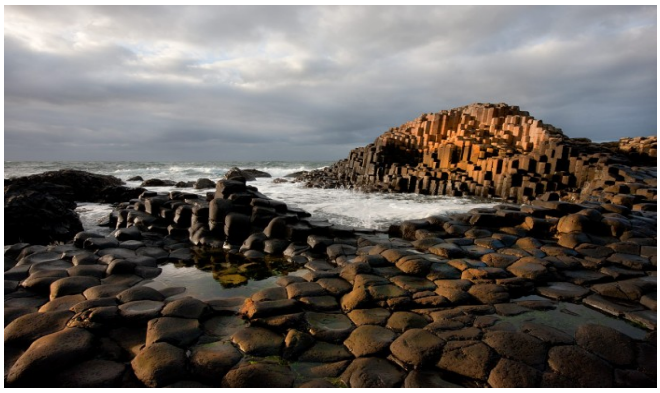
Οι καταιγίδες λάσπης συμβαίνουν όταν εμφανίζονται κεραυνοί πάνω από ηφαίστεια.

3. Οι μαγικοί κύκλοι της Ναμίμπια

Σύμφωνα με τους επιστήμονες αυτό το παράξενο φαινόμενο θεωρείται έργο των τερμιτών της άμμου.

4. Giants Causeway

Giants Causeway ή αλλιώς ο δρόμος των γιγάντων στη Ιρλανδία: Το φαινόμενο αυτό είναι προκλήθηκε από την έκρηξη αρχαίου ηφαιστείου στη Βόρεια Ιρλανδία και εμφανίστηκε αυτή η περιοχή που καλύπτεται με 40000 πυλώνες βασάλτη.



5. Φακοειδή σύννεφα

Είναι ένα στατικό με σχήμα φακού νέφος που σχηματίζεται συνήθως σε μεγάλο ύψος, συνήθως ευθυγραμμισμένο κάθετα στην κατεύθυνση του ανέμου. Όταν σταθερός υγρός αέρας περνάει πάνω από ένα βουνό ή οροσειρά, μια σειρά από στάσιμα κύματα μπορεί να δημιουργηθούν στη μεριά του κατωφερή αέρα. Εάν η θερμοκρασία στην κορυφή των κυμάτων πέσει κοντά ή κάτω από την θερμοκρασία δρόσου, η υγρασία του αέρα συμπυκνώνεται και δημιουργούνται φακοειδή σύννεφα. Καθώς ο αέρας κινείται ξανά μέσα στο κύμα, το σύννεφο εξατμίζεται.

6. Οι κεραυνοί του Catatumbo

Οι καταιγίδες πάνω από το νερό συμβαίνουν 140-160 νύχτες το χρόνο, 10 ώρες την νύχτα και μέχρι και 280 κεραυνοί την ώρα.

7. Τα κόκκινα καβούρια του Νησιού των Χριστουγέννων

Κάθε χρόνο περίπου 43 εκατομμύρια καβούρια έρχονται στην ακτή της θάλασσας, για να αφήσουν τα αυγά τους, με τις τοπικές αρχές να κλείνουν όλους τους δρόμους για μία εβδομάδα για να μην εμποδίσουν το φαινόμενο αυτό.

8. Η Μπλε Τρύπα του Μπελίζ

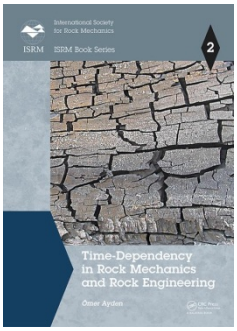
9. Σύννεφα Asperatus

Τα Asperatus είναι τόσο σπάνια, που δεν είχαν κατηγοριοποιηθεί από τους επιστήμονες μέχρι το 2009. Όπως και τα άλλα είδη κυματιστών νεφών, σχηματίζονται όταν θυελλώδεις άνεμοι και συγκρουόμενες αέριες μάζες μαστιγώνουν το κατώτατο στρώμα της νέφωσης σχηματίζοντας κομψούς σχηματισμούς. Πιο συχνά απαντιούνται στις μεγάλες πεδιάδες των ΗΠΑ

10. Λίμνη Νάτρον, Τανζανία

Πρόκειται για μια αλκαλική λίμνη στη βόρεια Τανζανία, κοντά στα σύνορα με την Κένυα. Καταλαμβάνει μια κοιλότητα στον ανατολικό κλάδο της μεγάλης ρηξιγενούς κοιλάδας της Αφρικής. Η λίμνη περιβάλλεται από ηφαίστεια, ανάμεσα στα οποία είναι και το ενεργό ηφαίστειο Ολ Ντόινιο Λενγκάι. Η έκταση της λίμνης δεν είναι σταθερή και μπορεί να φτάσει σε έκταση μέχρι τα 850 χλμ², αλλά είναι πολύ ρηχή και το βάθος της φτάνει μόνο το μισό μέτρο

ΝΕΕΣ ΕΚΔΟΣΕΙΣ ΣΤΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΠΙΣΤΗΜΕΣ

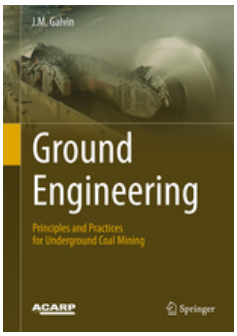


Time-Dependency in Rock Mechanics and Rock Engineering

Ömer Aydan

This book is concerned with time-dependency in rock mechanics and rock engineering, whose spectrum is very wide. While the term "time-dependency" involves time-dependent behavior/rate-dependent behavior of rocks in a conventional sense, this books attempts to cover the spectrum as much as possible including coupled processes of thermal, hydrological and diffusions in rocks. It presents theoretical formulations, experiments, numerical formulation and examples of applications. Of paramount concern is the long-term response and stability of rock engineering structures, including for instance man-made and natural slopes and underground facilities such as tunnels and powerhouses.

(CRC Press, December 12, 2016)



Ground Engineering - Principles and Practices for Underground Coal Mining

Galvin, J.M.

This book teaches readers ground engineering principles and related mining and risk management practices associated with underground coal mining. It establishes the basic elements of risk management and the fundamental principles of ground behaviour and then applies these to the essential building blocks of any underground coal mining system, comprising excavations, pillars, and interactions between workings.

Readers will also learn about types of ground support and reinforcement systems and their operating mechanisms. These elements provide the platform whereby the principles can be applied to mining practice and risk management, directed primarily to bord and pillar mining, pillar extraction, longwall mining, sub-surface and surface subsidence, and operational hazards.

The text concludes by presenting the framework of risk-based ground control management systems for achieving safe workplaces and efficient mining operations. In addition, a comprehensive reference list provides additional sources of information on the subject. Throughout, a large variety of examples show good and bad mining situations in order to demonstrate the application, or absence, of the established principles in practice.

Written by an expert in underground coal mining and risk management, this book will help students and practitioners gain a deep understanding of the basic principles behind designing and conducting mining operations that are safe, efficient, and economically viable.

- Provides a comprehensive coverage of ground engineering principles within a risk management framework
- Features a large variety of examples that show good and poor mining situations in order to demonstrate the application of the established principles in practice
- Ideal for students and practitioners

ΗΛΕΚΤΡΟΝΙΚΑ ΠΕΡΙΟΔΙΚΑ

http://www.issmge.org/publications/issmge-bulletin/vol-10-issue-5-october-2016

Κυκλοφόρησε το τεύχος αρ. 5 του 10ου τόμου του ISSMGE Bulletin Οκτωβρίου 2016 με τα παρακάτω περιεχόμενα:

- President's message
- Board Members' Corner: Sharing by Professor Vlasta Szavits-Nossan
- Research Highlights
  - Georgia Institute of Technology, USA
- Conference Reports
  - The 8th Asian Young Geotechnical Engineers Conference
  - The 2nd Youth Russian Geotechnical Engineer Conference & the 2nd Geo Games
  - The 3rd European Conference on Unsaturated Soils
- Young Members' Arena
- ISSMGE Foundation Reports
- Hot News
  - Book review: Reliability of Geotechnical Structures in ISO2394
- Event Diary
- Corporate Associates
- Foundation Donors

http://www.issmge.org/publications/issmge-bulletin/vol-10-issue-6-december-2016

Κυκλοφόρησε το τεύχος αρ. 6 του 10ου τόμου του ISSMGE Bulletin Δεκεμβρίου 2016 με τα παρακάτω περιεχόμενα:

- Member society's report
  - Vietnamese Society for Soil Mechanics & Geotechnical Engineering: Hansbo Lecture
- Conference Reports
  - GEO-EXPO 2016
  - GEOTEC HANOI 2016
  - International Geotechnical Engineering Conference on "Sustainability in Geotechnical Engineering Practices and Related Urban Issues"
- ISSMGE Foundation Reports
- Journal News
  - Case Histories Journal
  - Soils and Foundations
- Event Diary
- Corporate Associates
- Foundation Donors

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Κυκλοφόρησε το Τεύχος #140 του **Newsletter του Geo-engineer.org** (Δεκεμβρίου 2016) με πολλές χρήσιμες πληροφορίες για όλα τα θέματα της γεωμηχανικής. Υπενθυμίζεται ότι το Newsletter εκδίδεται από τον συνάδελφο και μέλος της ΕΕΕΕΓΜ Δημήτρη Ζέκκο (secretariat@geoengineer.org).

Ενδεικτικά αναφέρονται:

- Living with Shrink-Swell Soils: A what-to-do pamphlet for home-owners, prepared by ASCE Geo-Institute
- Debris Flow Recorded in Argentina
- Oso Washington Landslide Risk Goes Back Decades
- Sinkholes in Texas Oil Fields Growing Rapidly
- Landslide at Myanmar Jane Mine Kills 12 and More are Missing
- Amazing Concept House Being Built into a Cliff in Lebanon
- Chemical Weathering Deteriorating Mosul Dam
- Four Cars Swallowed by Sinkhole in Ruijin, China
- Dozens of Cars Fall Into 200 Meter Long Sinkhole in Florence
- Ottawa Sinkhole Swallows Three Road Lanes and a Minivan
- Geologists Recreate 4800 Year Old Zion Landslide
- Landslide in China Destroys Buildings
- Drivers Stop in Road to Avoid Landslide

http://campaign.r20.constantcontact.com/render?m=1101304736672&ca=81e12e30-ce04-4150-bd0b-0793cc961ecc

No. 36 - December 2016
https://www.isrm.net/adm/newsletter/ver_html.php?id_newsletter=132&ver=1

Κυκλοφόρησε το τεύχος αρ. 36, Δεκεμβρίου 2016 του NEWSLETTER της ISRM με τα ακόλουθα περιεχόμενα:

- President's 2017 New Year Address
- 16th ISRM online lecture was delivered by Prof. Giovanni Barla
- 2017 ISRM International Symposium - AfriRock 2017, 2-7 October, Cape Town, South Africa
- EUROCK 2017 "Human Activity in Rock Masses", Ostrava, Czech Republic
- 7th International Symposium in Geomechanics, Medellín, Colombia, 13-16 March 2017
- YSRM 2017 & NDRMGE 2017 – Challenges and Innovations in Rock Mechanics and Engineering,Jeju Island, South Korea, 10-13 May 2017

- Progressive Rock Failure Conference, 5-7 June 2017
- GeoProc 2017, Paris, France, 5-7 July
- First JTC1 Workshop on Advances in Landslide Understanding, Barcelona, 24-26 May 2017
- Time-Dependency in Rock Mechanics and Rock Engineering, by Ömer Aydan - a new book on the ISRM Book Series
- Ground Engineering - Principles and Practices for Underground Coal Mining, by Jim Galvin
- A Report on the 9th Asian Rock Mechanics Symposium, Bali, Indonesia
- A Report on the International Conference on Recent Advances in Rock Engineering (RARE-2016)
- Report on the GEO-EXPO 2016 Scientific and Expert Conference, Banja Luka, Bosnia and Herzegovina, 7-8 October 2016
- ISRM Sponsored meetings

ITA@NEWS

THE ITA@NEWS #62 - December 2016

https://www.ita-aites.org/es/publications/archives-ita/ita-news-archives/listid-1/mailid-152-ita-news-62?tmpl=component

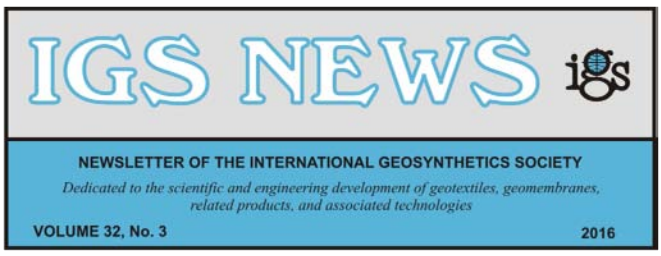
Κυκλοφόρησε το τεύχος αρ. 62, Δεκεμβρίου 2016 των ITA@NEWS με τα ακόλουθα περιεχόμενα:

- Message from Tarcisio CELESTINO, ITA President
- The Ita Tunnelling Awards' Winners Finally Revealed
- ITA Tunnelling Awards Video
- You can register for WTC 2017
- A visit to the Tunnelling Training Academy in Malaysia
- The ITA-CET Committee is to help develop a post-graduate Master's in Thailand
- Issue 5 of the ITA-CET Committee newsletter
- Candidates for COSUF Award 2017 apply now!
- ITA COSUF Newsletter
- YPTDP workshop Glasgow
- The success of the Glasgow YPTDP workshop
- Lee Tunnel
- Tunnelling Asia 2017 Conference: Design, Construction and Risk Management in Underground Construction: Issues and Challenges
- "First National Congress of Underground Works"
- 7th International Symposium on Tunnels and Underground Structures in South-East Europe, 4 - 5th May 2017, Croatia

The International Journal of Geoengineering Case Histories, an official Journal of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE), is pleased to announce the publication of Issue #1 of Volume #4 of the International Journal of Geoengineering Case Histories, an official Journal of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE). This is a special issue on case histories from Greece, guest edited by Michael Pachakis, Michael Bardanis and Christos Tsatsanifos, members of the Executive Committee of the Hellenic Society for Soil Mechanics and Geotechnical Engineering.

- Editorial, pp. i-iii Authors: Pachakis Michael, Bardanis Michael and Tsatsanifos Christos
- Reinforced Earth Used in Uncontrolled Landfill Final Closures - The Case of Syros Landfill, Page: 1-13 Authors: Platis Athanasios, Malliou Konstantina and Platis Dimitrios
- Remediation of the Pissouri Landslide in Cyprus, pp.14-28 Authors: Alexandris Argyris, Griva Irini and Abarioti Maria
- A Large Scale Landslide in a Coal Mine in Marly Formations: Evaluation, Analysis and Rehabilitation, pp. 29-45 Authors: Prountzopoulos George, Fortsakis Petros, Marinos Vassilis and Marinos Paul
- Estimation of the Hydroconsolidation Susceptibility of the Anthropogenic Fill of the Historical Center of Thessaloniki, Greece, pp. 46-56, Authors: Chatzigogos Nikolaos P.T., Makedon Thomas K., Tsindaris George E., Tsotsos Stefanos C. and Christaras Basile C.
- Rock Mass Characterization and Assessment of Ground Behavior for the Trikokkia Railway Tunnel (Central Greece), pp. 57-77 Authors: Alexandris Argyris, Abarioti Maria and Griva Irini

You can view the special issue by clicking on the following URL:
http://casehistories.geoengineer.org/volume/volume4/issue1/issue1.html



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Κυκλοφόρησε το Τεύχος 3 του Τόμου 32, των IGS NEWS με τα παρακάτω περιεχόμενα:

General Information for IGS Members

- IGS Web Site Has a New Look and Some New Features!
- Logging in to the New IGS Web Site!
- New Organisation of IGS after 2016 Election
- IGS Appoints Terry-Ann Paulo New Secretariat Manager

Technical Committees IGS-TC

- IGS TC-B Activities Report
- IGS TC-SR Activities Report
- IGS TC-H Activities Report

IGS Young Members

- IGS Young Members at EuroGeo 6

Conference Reports

- EuroGeo 2016
- GeoAsia 2016 6th Asian Regional Conference on Geosynthetics
- 3rd International Conference on Transportation Geotechnics (3rd ICTG 2016) – Workshop on Geosynthetics

Announcement of the International Conference of IGS

- 11th ICG International Conference on Geosynthetics

Announcements of Regional Conferences of IGS

- GeoAfrica 2017 – 3rd African Regional Conference on Geosynthetics

Announcements of Conferences under the Auspices of IGS

- Geotechnical Frontiers 2017
- EurAsian Geotextiles Symposium (EAGS)

News from the IGS Chapters and the Membership

- Hellenic Geosynthetics Society (HGS) Changes in Council
- Report on IGS Educate the Educators Program in China
- IGS Peru Announces GEOSPERU 2017
- Call for Nominations – IGS North America Board of Directors
- Continuation of FS-KGEO, The German National Geosynthetics Event

List of IGS Chapters

Official Journals of the IGS

- Geosynthetics International
- Geotextiles & Geomembranes

Corporate Membership

- Report on Corporate Committee Meeting 24 September 2016
- IGS Corporate Members Award at EuroGeo 6
- Case studies – use the chance!
- Geocells for a Culture Square near a Channel
- Geotextile formwork used as canal lining system
- The construction of the flood channel in Rees in the Lower Rhine region
- Kaytech has a Stabilising Effect at Groblersdal Mall
- Securing Hazardous Waste in Uganda
- Corporate Members of the IGS

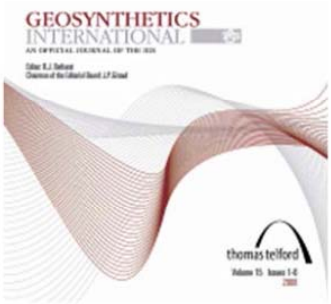
IGS News Publisher, Editor and Chapter Correspondents

IGS Council

IGS Officers

IGS Membership Application

Calendar of Events



Content of Volume: 23, Issue: 5 (October 2016)

Influence of fibers on the shear strength and dewatering performance of geotextile tubes, M. M. Khachan, S. K. Bhatia

Soil–geosynthetic interaction in pullout and inclined-plane shear for two geosynthetics exhumed after installation damage, M. Pinho-Lopes, A. M. Paula, M. L. Lopes

Field test of a geogrid-reinforced and floating pile-supported embankment, W. Z. Cao, J. J. Zheng, J. Zhang, R. J. Zhang

Coupled discrete and finite-element modelling of geosynthetic tubes filled with granular material, J. Górniak, P. Villard, P. Delmas

Diffusion of phenolic compounds through two high-density polyethylene geomembranes after 17 years under different exposure conditions, N. Touze-Foltz, M. Mendes, F. Farcas, L. Mazéas

Laboratory study on the use of EPS-block geofoam for embankment widening, A. T. Özer

Content of Volume: 23, Issue: 6 (December 2016)

Best *Geosynthetics International* Paper for 2015, R.J. Bathurst

Reduction of lateral pressures on retaining walls using geofoam inclusion, S. S. AbdelSalam, S. A. Azzam

Polychlorinated biphenyl diffusion through HDPE geomembrane, R. K. Rowe, D. D. Jones, A. Rutter

The influence of tensile strain on the pore size and flow capability of needle-punched nonwoven geotextiles, C. S. Wu, Y. S. Hong

Numerical parametric study on behavior of bearing reinforcement earth walls with different backfill material properties, K. Sukmak, J. Han, P. Sukmak, S. Horpibulsuk

Diffusion of bisphenol-A (BPA) through an HDPE geomembrane, P. T. Saheli, R. K. Rowe, A. Rutter

Hydraulic deterioration of geosynthetic filter drainage system in tunnels – its impact on structural performance of tunnel linings, C. Yoo

Please find the download of the articles at:
http://www.icevirtuallibrary.com/content/issue/gein/23/5
http://www.icevirtuallibrary.com/content/issue/gein/23/6
For the IGS members to have FREE access to the papers they MUST log in through the IGS website.

Geotextiles and Geomembranes

Content of Volume 44, issue 5 (October 2016)
Developments in Geosynthetics for Environmental Protection

Editorial

Foreword to special issue on developments in geosynthetics for environmental protection, Abdelmalek Bouazza, Nathalie Touze-Foltz

Regular Articles

A review of the performance of geosynthetics for environmental protection, N. Touze-Foltz, H. Bannour, C. Barral, G. Stoltz

Geosynthetics in Antarctica: Performance of a composite barrier system to contain hydrocarbon-contaminated soil after three years in the field, R.S. McWatters, R.K. Rowe, D. Wilkins, T. Spedding, D. Jones, L. Wise, J. Mets, D. Terry, G. Hince, W.P. Gates, V. Di Battista, M. Shoaib, A. Bouazza, I. Snape

Field and laboratory observations of down-slope bentonite migration in exposed composite liners, R. Kerry Rowe, Richard W.I. Brachman, W. Andy Take, Amy Rentz, Lauren E. Ashe

Limiting membrane and diffusion behavior of a geosynthetic clay liner, Charles D. Shackelford, Amara Meier, Kristin Sample-Lord

Membrane efficiency and diffusive tortuosity of a dense prehydrated geosynthetic clay liner, Michael A. Malusis, Akmal S. Daniyarov

Sorption and diffusion of bisphenol-A (BPA) through a geosynthetic clay liner (GCL), Pooneh T. Saheli, R. Kerry Rowe

Hydraulic conductivity and swelling ability of a polymer modified bentonite subjected to wet–dry cycles in seawater, Michela De Camillis, Gemmina Di Emidio, Adam Bezuijen, Ramiro Daniel Verástegui-Flores

Potential hydraulic barrier performance of cyclic organic carbonate modified bentonite complexes against hypersalinity, A. Fehervari, W.P. Gates, A.F. Patti, T.W. Turney, A. Bouazza, R.K. Rowe

Predicting self-healing ratio of GCL with a damage hole, Jin-Chun Chai, Kartika Sari, Shui-long Shen, Yuanqiang Cai

Investigations of geomembrane integrity within a 25-year old landfill capping, Eugene M. Gallagher, David M. Tonks, John Shevelan, Andrew R. Belton, Ria E. Blackmore

Content of Volume 44, issue 6 (December 2016)

Geotextiles and geomembranes: Best papers in 2015, R. Kerry Rowe

Numerical modeling of the nonlinear mechanical behavior of multilayer geosynthetic system for piggyback landfill expansions, Bekoin Francis Guillaume Tano, Daniel Dias, Gary John Fowmes, Franck Olivier, Guillaume Stoltz, Nathalie Touze-Foltz

Lateral bearing capacity and failure mode of geosynthetic-reinforced soil barriers subject to lateral loadings, Kuo-Hsin Yang, Jonathan T.H. Wu, Rong-Her Chen, Yi-Shou Chen

Deterministic and probabilistic prediction of facing deformations of geosynthetic-reinforced MSE walls using a response surface approach, Bo-Hung Lin, Yan Yu, Richard J. Bathurst, Chia-Nan Liu

Geotextile biofiltration of primary treated municipal wastewater under simulated arctic summer conditions, Evan Bridson-Pateman, Rob Jamieson, Craig Lake

Evaluating reinforcement loading within surcharged segmental block reinforced soil walls using a limit state framework, Yonggui Xie, Ben Leshchinsky, Shangchuan Yang

Performance of geosynthetic reinforced/stabilized paved roads built over soft soil under cyclic plate loads, Murad Abu-Farsakh, Shadi Hanandeh, Louay Mohammad, Qiming Chen

Particle size effects on coarse soil-geogrid interface response in cyclic and post-cyclic direct shear tests, J. Wang, F.Y. Liu, P. Wang, Y.Q. Cai

Experimental study on the behaviour of geogrid-reinforced slopes with respect to aggregate size, Gh. Tavakoli Mehrjardi, A. Ghanbari, H. Mehdizadeh

Investigation on the interfacial mechanical behavior of wave-shaped fiber reinforced soil by pullout test, Chao-Sheng Tang, Jian Li, De-Yin Wang, Bin Shi

Discussion of "Centrifuge evaluation of the time-dependent behavior of geotextile-reinforced soil walls" by C.M.L. Costa, J.G. Zornberg, B.S. Bueno, Y.D.J. Costa, Huabei Liu, Chunhai Wang

Reply from authors Costa, C. M. L., Zornberg, J. G., Y. D. J. Costa. "Centrifuge evaluation of the time-dependent behavior of geotextile-reinforced soil walls", Carina Maia Lins Costa, Jorge Gabriel Zornberg, Yuri Daniel Jatobá Costa

Discussion of Xiao C. et al., "Experimental study on performance of geosynthetic-reinforced soil model walls on rigid foundations subjected to static footing loading, Jonathan T.H. Wu, Michael T. Adams, Jennifer E. Nicks

Experimental study on performance of geosynthetics reinforced soil model walls on rigid foundations subjected to static footing loading: Response to discussion by J. T. H. Wu, M. T. Adams, and J. E. Nicks, C. Xiao, J. Han, Z. Zhang

Discussion of "Feasibility study of copper slag as a structural fill in reinforced soil structures" by P.S. Prasad and G.V. Ramana, Dongsheng Xu

Reply for Dr. Xu's discussion of "Feasibility study of copper slag as a structural fill in reinforced soil structures" by P.S. Prasad and G.V. Ramana, P.S. Prasad, G.V. Ramana

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