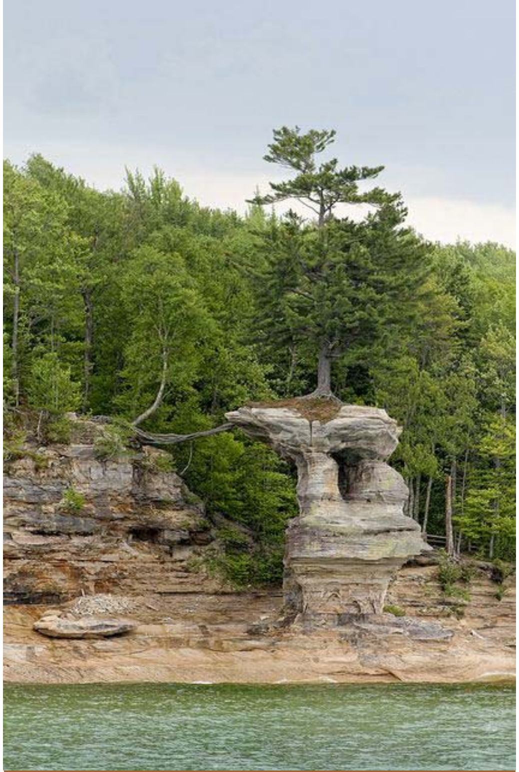

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Παρουσίαση άρθρων, στην συγγραφή των οποίων μετείχαν Έλληνες, στο XVI European Conference on Soil Mechanics and Geotechnical Engineering, Edinburgh, 13-17 September 2015 (κατ' αλφαβητική σειρά, στα ελληνικά, του ονόματος του πρώτου συγγραφέα).

Estimation of vertical subgrade reaction modulus for sands from CPT investigations

Estimation de la plate-forme verticale module de réaction pour les sables d'enquêtes du CPT

N. Barounis and P. McMahon

ABSTRACT A method for the rapid estimation of the subgrade reaction coefficient k for sands was introduced in 2013 (Barounis et al.) from CPT data. In this paper the method is applied for a building site in Christchurch, New Zealand that suffered structural damage from the recent Canterbury earthquakes. The method is relying on qc measured and a value for k from CPT (KCPT) is obtained. This value is further corrected for size effects and after the use of a back calculated factor of safety, the value corresponding for a given foundation shape and depth is estimated. The results correlate sufficiently with published values for foundations on loose to medium dense sands.

1 INTRODUCTION

After the recent earthquakes in Canterbury, New Zealand the demand for the rebuild of the city of Christchurch resulted in extensive CPT investigations. These investigations reveal great information for the liquefaction potential of the underlying soils at a very affordable cost. For upgrading damaged foundations or for the design of new foundations structural engineers need to adopt representative values for the subgrade reaction k. Unfortunately when a city of such scale is under rebuild recovering from earthquake damage it becomes a luxury to perform expensive plate load testing. Thus a method for the rapid estimation of k from conventional CPT data was introduced for delivering values at a small amount of time and low cost (Barounis et al.2013).

The coefficient of subgrade reaction k (or subgrade reaction modulus after Terzaghi, 1955) is a conceptual relationship, which is defined as the pressure σ exerted on a soil divided by the measured deflection δ as a result of the exerted pressure:

$$k=\sigma/\delta \ [N/m^3] \qquad (1)$$

The usual procedure for measuring k is to perform in situ plate load tests. The plate load test for a number of reasons has technical limitations and cost constraints (Barounis et al., 2007, 2011 and 2013).

In this paper it is proposed that these limitations can be overcome by using standard CPT data. The proposed methodology estimates k in the field by means of the tip cone resistance q_c and cone penetration δ. The k value estimated from the CPT will carry the symbol K_{CPT} throughout this paper. The method can be applied mainly for the design of shallow foundations on sands but it may also be extended for the design of deep foundations and liquefaction analysis.

The results from a site investigation in Christchurch, New Zealand are used for the estimation of k for given foundations. The site investigation comprises of one CPT and one borehole with SPT's 5 metres away from the CPT. The results from both CPT and SPT methods are compared.

2 BACKGROUND THEORY

The proposed method is to obtain K_{CPT} directly from CPT's by dividing the stress qc (cone resistance) applied on the ground by the amount of deflection δ, taken to be equal to the cone penetration into the ground. Usually the amount of recorded deflection δ that corresponds to a value of qc has the same increment for the whole depth of the test and ranges in practice between 10 and 50 millimeters. Every pair of values of qc and δ that are recorded during testing may be used until the final depth is reached.

The K_{CPT} values may be computed for every depth increment until the final depth of the test enabling a continuous K_{CPT} plot versus depth to be prepared. From this graph the subgrade reaction coefficient can be delineated with depth which enables the direct calculation of the vertical subgrade reaction coefficient for foundations of any shape, at any depth of interest by applying well established methodologies (Bowles, 1997; Das, 1990). The transformation from K_{CPT} to $K_{FOUNDATION}$ can be performed by applying formulae presented in the next paragraphs of this paper.

The tip resistance of the cone qc, defined as the vertical force in MPa acting on the penetrometer tip divided by the base area recorded during the test versus testing depth. Pore pressures u can also be measured during penetration in the piezocone version of CPT testing and in this case the total cone resistance qt is calculated by:

$$q_t = q_c + (1\text{-}a)\ u \qquad (2)$$

where

q_t=corrected cone resistance [MPa]
q_c= tip cone resistance [MPa] measured at any depth
a=dimensionless area ratio= 0.70 to 0.85
u=measured pore pressure [MPa] at the same depth as q_c

During cone penetration the soil is initially compressed and then sheared to failure at a stress equal to the measured value of q_c. The rate of cone penetration of δ=2 centimeters per second classifies this type of testing as strain controlled in-situ testing, similarly to the laboratory triaxial and unconfined compression tests.

Each soil layer of thickness T can be perceived as a series of vertical springs 1 cm long connected in series, each spring having an ultimate vertical reaction coefficient value of K_{CPT}, which is fully mobilized during cone penetration. The cone penetration test offers the ability to measure this ultimate reaction coefficient K_{CPT} for the complete depth of the profile as both q_c and δ are measured.

For defining mathematically K_{CPT} two soils of random cone penetration resistance are shown in Figure 1 below on a q_c/δ graph. The first corresponds to a very dense/hard soil with qc of 100MPa and the second to a soft/loose soil with qc of 5MPa. In both soils the cone undergoes the same penetration of 1cm. From this graph the subgrade coefficient K_{CPT} is defined as the slope of the straight line q_c/δ, which for the first soil is 10,000MN/m^3 and 500MN/m^3 for the second. From this graph is evident that the first soil is 20 times stiffer than the second soil.

A horizontal dashed line is shown at the value of q_c. At this stress value the soil fails, as this was proved during testing. Thus, the q_c/δ graph for any soil tested at any depth h as the form of a straight line starting from the origin of the axes and finishing at the point whose coordinates are the measured q_c at failure and the recorded deflection δ (for which some use the term quake). Thus an elastic-plastic model is assumed for the soil. The K_{CPT} beyond the point of failure cannot be defined, but one can assume the line becomes horizontal due to the soil being incapable of sustaining any more stress. At this failure point and beyond, the soil is considered as behaving as a spring which has reached its ultimate stress limit and failed. The duration of testing for 1cm of soil is between 0.5 to 1 seconds, and for such duration the test can be classified as undrained. The undrained character of the testing and a well maintained and calibrated CPT probe can let us assume with a lot of confidence that for each centimeter tested a straight line can be always drawn as shown in Figure 1. For sands and sandy soils the pore pressure u equals 0 and q_t is equal to q_c.

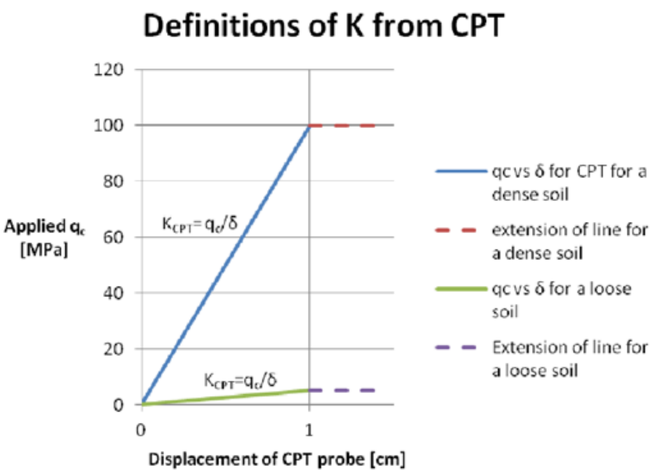

Figure 1. Definition of K_{CPT} [MN/m^3] by using a q_c/δ graph for a hard and a soft soil for a CPT with δ=1cm.

For foundation design the K_{CPT} value it is not of direct use as the dimensions of the foundation under design is several orders of magnitude greater than the diameter of the CPT probe used. Thus a scale factor needs to be applied to the K_{CPT} before it is used in foundation design. These scaling factors are discussed in the next paragraphs.

3 PROCEDURE OF ANALYSIS

The proposed procedure for calculating the K_{CPT} and K_{FCPT} values can be summarised in three steps:

Step1:K_{CPT} = q_c / δ = q_c / (0.01m) = 100q_c (3)

where

K_{CPT} = coefficient of subgrade reaction from CPT [MN/m^3}
q_c= tip cone resistance measured at any depth [MPa]
δ = cone penetration of 1 centimeter

and

K_{CPT} = q_c / δ = q_c /(0.02m) = 50q_c [MN/m^3] (4)

when δ = 2 centimetres

The above equations cover most of the cases of CPT rigs.

Step 2: conversion to K_{CPT} (0.3)

$K_{CPT(0.3)}$ = K_{CPT} x (D_{CPT} / 300) (5)

where

$K_{CPT(0.3)}$ coefficient of subgrade reaction for a 300mm load plate based on CPT measurements
D_{CPT} = the diameter of the cone used in mm
300 = the reference plate diameter in mm
K_{CPT} = the subgrade reaction coefficient calculated according equation 3 or equation 4, depending on the penetration increment used [N/M^3].

The usual cone penetrometer diameter D_{CPT} is 35.7mm, hence $K_{CPT(0.3)}$ is given by:

$K_{CPT(0.3)}$ = K_{CPT} x (35.7/300) =0.119 K_{CPT} ≅ 12% K_{CPT}

Step 3: Conversion of $K_{CPT(0.3)}$ to K_{FCPT} values that correspond to a given foundation shape and depth by using well established methodologies.

4 COMPARISON BETWEEN CPT AND SPT TESTING

Recent research on the applicability of the proposed method on sandy soils (Barounis et al., 2013), showed that the CPT method estimates higher $K_{CPT(0.3)}$ values than the following well established methods.

The relationship proposed by Scott (1981) applicable to coarse grained soils:

$K_{0.3}$=1.8N (6)

where

$K_{0.3}$ =coefficient of subgrade reaction for a 300mm diameter load plate [N/m^3]
N = corrected SPT blow N

The relationship proposed by Moayed and Janbaz (2011) applicable to dense to very dense gravelly soils:

$K_{0.3}$ = 2.821N (7)

where

$K_{0.3}$ =coefficient of subgrade reaction for a 300mm diameter load plate [N/m^3]
N = corrected SPT blow N

By comparing CPT results with SPT results on sandy soils to 10m depth, it was found that 83% of the CPT measurements indicated higher $K_{CPT(0.3)}$ values than the corresponding $K_{0.3}$ values from the above two methods.

The authors believe that the main reasons for these higher values are the following:

- CPT is a failure test; SPT is not a failure test
- Intermittent pattern of SPT with depth; continuous recording of CPT with depth
- Plate load test is not always a failure test; it usually ceases when 25mm of deflection is recorded.

Thus it is considered that the results from each test have to be treated differently and according to the advantages and limitations each test offers.

5 STEPS FOR THE CALCULATION OF KFCPT

The calculation for K_{FCPT} from CPT data for an actual foundation with dimensions B and L founded at foundation depth D_f can be undertaken by the following steps.

Step 1: Obtain a characteristic value for q_c to be adopted for foundation design. This value should be representative of:

- the soil type for a distinct layer and the state of packing (i.e. relative density for cohesionless soils)
- the founding layer but also extended for some distance below the foundation; this distance should be related to the pressure bulb geometry.

A typical distance 2 to 4 times the foundation breadth (2B to 4B) below the foundation level may be analysed before adopting q_c for design. Engineering judgement should be exercised for adopting a suitable q_c value as it may affect the occurrence of the limit state by using the following recommended statistical techniques:

- Average q_c may be used for structures of low to medium importance level;
- Procedure for obtaining characteristic value X_k as defined by EC7 may be used for higher importance levels or structures of higher occupancies or risk (i.e. 95% confident mean value) (Bond, 2011);

Step 2: Estimation of K_{CPT} value by using one of the equations 3 or 4 above, depending on the applied penetration δ;

Step 3: Convert the K_{CPT} to $K_{CPT(0.3)}$ by using equation 5;

Step 4: Convert $K_{CPT(0.3)}$ to K_{FCPT} values by using the following equations:

For strip, pad or raft foundations on medium dense sand:

$$K_{FCPT} = K_{CPT(0.3)} \times [(m + 0.5) / 1.5m] \quad (8)$$

where m = L/B (Bowles,1997).

For the same types of foundations on sands of any relative density:

$$K_{FCPT} = K_{CPT(0.3)} \times [(B + B_1) / 2B]^2 \quad (9)$$

where B_1=0.3 m (reference plate width) and B=actual foundation width (Bowles, 1997;Das, 2004).

Step 5: Divide the estimated K_{FCPT} by a suitable factor of safety. The role of this factor of safety is to produce k values of the same order of magnitude to the values obtained from SPT methods. These methods have been used for more than 30 years in foundation design with adequate foundation performance. The recommended values for the factor of safety for loose to medium dense sands are discussed in the next paragraph.

6 AN APPLICATION FOR FOUNDATIONS IN CHRISTCHURCH

In Figure 1 are presented the results from one CPT and SPT tests conducted in a borehole for an earthquake damaged building site on Brougham Street, Christchurch, New Zealand. The buildings of the site suffered structural damage from the recent earthquake activity. The ground is consisting of loose to medium dense sandy soils extending to about 30m below ground level. The depth of both investigations is 10 meters and the distance between them is 5 meters. The stratigraphy and main soil types to 10m depth are:

- 0m to 3.5m: silty fine sand, loose
- 3.5m to 7m: silt with some sand, medium dense
- 7m to 10m: fine to medium sand, medium dense

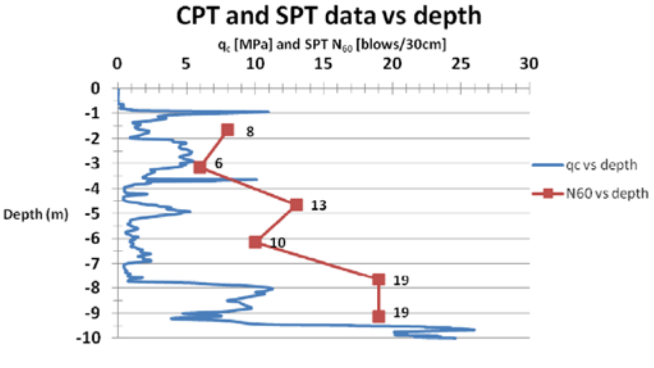

Figure 2.

Some existing isolated pad foundations at the site have the following geometries:

- Foundation depth D_f=1m, B=1m and L=1m
- Foundation depth D_f=1m, B=1m and L=2m
- Foundation depth D_f=1m, B=2m and L=3m

The proposed method was applied for the estimation of the subgrade coefficient as explained above. An average value for q_c was adopted to a depth of 2B and 4B below the foundation level of 1m for all three cases to check the sensitivity of the method and data. By following the steps presented in paragraph 5, the subgrade reaction modulus for each of the three foundations was estimated. The results are presented in Tables 1 and 2. The results from the proposed method are also compared with the methods proposed by Scott and by Moayed and Janbaz.

By comparing the values in Tables 1 and 2, it is evident that the results from the proposed method are higher than the results from the other two methods as expected.

Table 1. Results of $K_{FOUNDATION}$ values by adopting foundation influence depth of 2B

Df, B, L [m]	q_{cav} [MPa]	K_{CPT} [MN/m^3]	$K_{CPT(0.3)}$ [MN/m^3]	$K_{FOUNDATION}$		
				Proposed Method K_{FCPT} eq.8 (eq.9)	Scott's Method K_{FSCOTT} eq.8 (eq.9)	Moayed and Janbaz Method $K_{FM\&J}$ eq.8 (eq.9)
1,1,1	3.44	344	40.9	40.9 (17.3)	14.4 (6.1) N_{60}=8	22.6 (9.5) N_{60}=8
1,1,2	3.44	344	40.9	34.1 (17.3)	14.4 (6.1) N_{60}=8	22.6 (9.5) N_{60}=8
1,2,3	2.94	294	35	31.1 (11.6)	17.6 (7.5) N_{60}=9.8	27.6 (11.7) N_{60}=9.8

Diameter D_{CPT} of cone used: 35.7mm
D_f=foundation depth
B=foundation breadth
L==foundation length
q_{cav}: average tip cone resistance [MPa] for a depth of 2B beneath foundation
N_{60}: Corrected SPT blow number/30cm for a depth of 2B beneath foundation

Table 2. Results of $K_{FOUNDATION}$ values by adopting foundation influence depth of 4B

Df, B, L [m]	q_{cav} [MPa]	K_{CPT} [MN/m^3]	$K_{CPT(0.3)}$ [MN/m^3]	$K_{FOUNDATION}$		
				Proposed method K_{FCPT} eq.8 (eq.9)	Scott's Method K_{FSCOTT} eq.8 (eq.9)	Moayed and Janbaz method $K_{FM\&J}$ eq.8 (eq.9)
1,1,1	2.94	294	35	35 (14.8)	17.6 (7.5) N_{60}=9.8	27.6 (11.7) N_{60}=9.8
1,1,2	2.94	294	35	29.2 (14.8)	17.6 (7.5) N_{60}=9.8	27.6 (11.7) N_{60}=9.8
1,2,3	3.31	331	39.4	35 (13)	23.2 (9.8) N_{60}=12.9	36.4 (15.4) N_{60}=12.9

Diameter D_{CPT} of cone used: 35.7mm
D_f=foundation depth
B=foundation breadth
L==foundation length
q_{cav}: average tip cone resistance [MPa] for a depth of 4B beneath foundation
N_{60}: Corrected SPT blow number/30cm for a depth of 4B beneath foundation

The results from the proposed method are generally within the expected order of magnitude for rectangular foundations on loose and medium dense sand (Bowles, 1997).

For determining the factor of safety with which K_{FCPT} has to be divided before it is used for design, the ratios $K_{0.3CPT}$ / $K_{0.3Scott}$ and $K_{0.3CPT}$ / $K_{0.3M\&J}$ have been determined for the total depth of the CPT undertaken. These ratios indicate how many times greater is the $K_{0.3}$ from CPT method over the SPT methods. The minimum, average and maximum values for these ratios are presented in Table 3. The ratios obtained were independent of the depth tested and consistently higher than unity for the total depth of 10metres tested when compared with Scott's method.

Table 3. Results of statistical analysis for the proposed factor of safety

	$K_{0.3CPT}/K_{0.3Scott}$	$K_{0.3CPT}/K_{0.3M\&J}$
Minimum	1.24	0.79
Maximum	4.49	2.86

Thus the recommended factor of safety for transformation of K_{FCPT} to equivalent K_{FSPT} is 2.4 and 1.5 respectively for the methods compared.

7 CONCLUSIONS

A methodology for estimating the coefficient of subgrade reaction from CPT testing was applied on sandy alluvial soils in Christchurch. The method was applied on existing foundations with acceptable results for foundation design. A factor of safety of 2.4 and 1.5 was back calculated and is strongly recommended to be applied on the calculated K_{FCPT} values for transformation to equivalent K_{SCOTT} and $K_{M\&J}$ respectively. For the time being the analysis presented is limited to sandy soils with measured in situ SPT N values between 6 and 19 blows. Thus the method needs still to be proved that gives consistent values for the complete set of blows N between 1 and 50.

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Geotechnical considerations in the design of pipeline installation across major water courses by Horizontal Directional Drilling (HDD)

Considérations géotechniques dans la conception d' installation des conduits à travers des rivières par Forage Directionnel Horizontal (FDH)

S. C. Bandis, E.A. Bacasis, R. A. MacKean and J. C Sharp

ABSTRACT: Most HDD river crossings are executed through unconsolidated sediments, usually too weak to achieve an intrinsically stable hole. The operation requires constant stabilisation via mud pressure and circulation against the latent risk of hole collapse. The paper focuses on the interaction between the HDD process, mud stabilisation effects and ground conditions. Numerical analyses have been applied to identify broad patterns of stability in relation to hole size, effective stress state, uniform vs. mixed ground, soil strength and operational aspects.

1 INTRODUCTION

Horizontal Directional Drilling (HDD) is an advanced technology technique for trenchless crossing of obstacles. Installation of pipelines for gas, water and oil transportation is a common application of HDD. A currently designed >700 km pipeline in Northern Greece (Trans-Adriatic Gas Pipeline, TAP) will require approximately 1800 crossings of natural and man-made obstacles.

The main dimensions controlling HDD pipeline installation feasibility are the length of bore and the required diameter of hole. Current maximum HDD lengths in competent materials may reach 3000m or more for installation of medium / small size pipes (OD<10''). In such cases, the principal difficulty is the transmission of adequate torque and pressure via the flexible pipeline string. Soft, weak soils are easier to drill through but more difficult to maintain stability and direction of HDD bores. HDD lengths in river or sub-sea crossings rarely reach 2000m and pipe OD are usually <20''.

Construction difficulties may arise from inadequate planning, lack of contingency planning, inexperienced personnel and over-estimation of technical capabilities. Design deficiencies often, however, are associated with incomplete understanding of the subsurface conditions.

This paper aims to contribute to better understanding of the somewhat complex interactions of the ground, the bore opening, the engineered drilling fluid (mud) and the ambient water pressure in the soil. This is an essential step in appreciation of project feasibility, risk and improved HDD design.

2 INFLUENCE OF GROUND CONDITIONS

The nature of the soil is a significant factor in HDD project feasibility and design (Table 1). Understanding the geological history that gave rise to a proposed drill path corridor provides an initial and important forecast of the types of materials to be expected, as well as the potential for any undesirable physical inclusions. Geotechnical characterisation assigns parameters to the geological model and allows analysis of problems relating to drillability, hole stability and mud engineering.

Cohesive soils may be self-supporting but drilling through cohesionless materials requires constant hole stabilisation via mud pressure control.

Coarse-grained soils are not readily fluidised by drilling muds and can present a serious constraint to the feasibility of an HDD bore if encountered. Isolated boulders or layers of cobbles within the drilled envelope present an obstacle to the bit, reamer and the pipeline.

Table 1 HDD Feasibility Guidelines Based on Types of Soil Materials(Willoughby, 2005)

Type of Material	Gravel % by Weight	HDD Feasibility
Clay (wide strength range)	NA	Good to excellent
Very loose to very dense sand with or without gravel	0-30	Good to excellent
Very loose - very dense gravelly sand	30-50	Marginal - Drilling fluid critical to success
Very loose to very dense sandy gravel	50-85	Questionable
Very loose to very dense gravel	85-100	Extremely difficult to impossible

Since soil permeability controls containment of the drilling fluid in the hole, medium to coarse grained granular materials (e.g. gravels, cobbles, boulders) are generally regarded as adverse and, if possible, avoided for HDD alignments.

"Mixed" ground conditions can also represent adverse geotechnical conditions for HDD. These can include the presence of highly permeable gravel and sand layers and 'contamination' of otherwise uniform soil by isolated large boulders.

In summary, unexpected medium to coarse granular materials (e.g. gravels, cobbles and boulders with significant void ratio) can give rise to a number of problems to the drilling process. These include improper drilling fluids, delays in the boring operation, excessive ingress of water, inefficient mud circulation or hydrofracturing (exceedance of minimum overburden pressure). These problems may ultimately cause bore instability or collapse during drilling of the pilot hole that can result in the cutting tools and drill string becoming irretrievably jammed.

A prime objective of HDD crossing alignment selection and design is to mitigate, as far as practicable, the impact and effects of high-risk geological materials. A key element of all HDD designs should thus be a comprehensive geotechnical investigation to identify the soil profile and the engineering characteristics of the materials at the depths of interest.

A special and particular issue in major river crossings in deltaic or semi-deltaic environments is the evolution of the horizontal path of the river course through meandering and the localised vertical penetration through river bed scouring.

3 HOLE STABILITY

Stresses and deformations in the material surrounding the HDD bore evolve interactively as both the natural (soil or rock surround) and engineered components (in this case drilled hole and drilling fluid) establish a state of equilibrium. The stiffness of the ground around the bore will have an overriding influence on the stress - deformation path of the drilled cross section and its strength will determine whether equilibrium can be attained with or without engineered support (mud pressure in the HDD bore).

If the bored hole does not deform significantly following drilling and the ground materials exhibit a quasi-elastic response, arching will establish and support the earth loads. If the hole is intrinsically unstable, adequate internal pressure must be provided at all times by the use of engineered mud slurry. The pressure inside a drilled hole varies with both the dynamic pressure required to maintain the return flow and the static hydraulic pressure head back to the entry pit. A minimum pressure head is needed in the borehole to prevent collapsing, provided that an effective membrane of mud (filter 'cake') is formed on the hole walls. This comprises an accumulation of clay particles in the bore wall under pressure providing a "cut-off" to slurry losses and head build-up.

Generally, the increment of internal 'pseudostatic' pressure required to maintain a hole open is some 30-40 kPa above the hydrostatic pressure of groundwater. If the 'pseudostatic' pressure is higher than the confining pressure of overburden, then drilling fluid may be lost through the borehole wall.

4 NUMERICAL INVESTIGATION OF HOLE STABILITY

Numerical scoping analyses were conducted to assess:

- The degree of implied bore stability under controlled drilling operations in relation to depth of cover, hole size, strength/stiffness of soil and type of ground (uniform vs. mixed)
- The sensitivity of bore stability to inferred changes in the mud pressure
- Plausible instability mechanisms

4.1 Methodology and Input Assumptions

The software used includes two state-of-art numerical codes for stress-deformation geotechnical analysis, namely:

- FLAC (Fast Lagrangian Analysis of Continua)
- PFC (Particle Flow Code)

Both programs are suited for analysis of soil masses, but differ in that FLAC models the soil as a continuum, whereas *PFC* models the soil as a "microdiscontinuum" comprising discrete particles of soil in contact.

FLAC is a two-dimensional explicit finite difference program (Cundall, 1976) in which materials are represented by elements behaving according to a prescribed stress-strain law in response to applied forces.

PFC models the movement and interaction of spherical particles by the distinct element method (DEM) as described by Cundall and Strack (1979). The contact behaviour is simulated by a stiffness model, a slip model (frictional reaction) and a bonding model ("cohesive strength"). PFC proved to be an appropriate modelling method for simulation of boulder inclusions in the fine-grained soil matrix.

The underlying modeling principle is that after a ground model has attained an initial (at rest) equilibrium state, the perturbation caused by opening of a hole with or without internal pressure will cause redistribution of the initial stresses in the hole surround and accompanying deformations. The stress deformation analysis examines whether the model attains a new state of equilibrium or undergoes failure as a result of 'plastic' displacements around the hole caused by exceedance of the soil strength.

Tables 2 and 3 below summarise the soil material input parameters for the FLAC and PFC analyses and the matrix of analyses executed.

4.2 FLAC Analyses Results

The range of conditions simulated by the FLAC models is outlined in the matrix diagram below (Table 4). The simulations included a 44'' hole drilled in weak soil under low cover (14m) and in stronger soil under higher cover (38m). In both models the hydrostatic pressure was 400 kPa. The geometry of the models is illustrated at the top of Figure 1.

The analyses performed and the main findings of are presented in Table 5 and Figure 1 and discussed below.

Table 2 Input data of FLAC analyses

	WEAK SOIL*				STRONG SOIL**			
Plastic strain	0%	1%	10%	15%	0%	1%	10%	15%
Cohesion, c (kPa)	40	2.5	.25	0	100	15	3	0
Angle of friction, Φ(°)	30	26	22	20	35	29	26	25
Dilation angle (°)	3	2	1	0	5	3	1	0
Tensile strength (kPa)	20	1.5	0	0	40	6	1	0
Young's Modulus, E (Pa)	$8x10^6$				$15x10^6$			
Poisson's Ratio, ν	0.40				0.40			
Bulk Modulus, K (Pa)	$1.333x10^7$				$2.50x10^7$			
Shear Modulus, G (Pa)	$2.857x10^6$				$5.36x10^6$			

(*) Typically medium dense silty sand (N≤20)
(**) Typically dense silty sand (N≥40)

Table 3 Input data of PFC analyses(weak soil)

Contact normal stiffness (Pa/m)	$40x10^6$
Contact shear stiffness (Pa/m)	$30x10^6$
Coefficient of friction (μ)	0.578 (Φ=30°)
sbond (Pa)	5
nbond (Pa)	5

Table 4 Matrix of FLAC analyses of 44'' hole

I - WEAK SOIL	II - STRONG SOIL
Depth of cover 14m	Depth of cover 38m

Hydrostatic pressure at depth of hole P_W=400 kPa

Analyses: P_{MUD}=0 (Intrinsic state)
$P^{EL}_{MUD}=P_W+\Delta P$ $\quad$ $P^{LS}_{MUD}=P^{EL}_{MUD}-\Delta P$

NB1: P^{EL}_{MUD}=Internal pressure required for elastic response
NB2: P^{LS}_{MUD}=Internal pressure required for limit state response

Table 5 Summary of 44''hole FLAC analyses results

WEAK SOIL (LOW COVER)			*STRONG SOIL (HIGH COVER)*			*Stability State*
Mud Pressure	*Max dis (mm)*	*Plot on Fig.1*	*Mud Pressure*	*Max dis (mm)*	*Plot on Fig.1*	
0 kPa	*>500*	*Ib*	*0 kPa*	*>200*	*IIb*	*Collapse*
430 kPa	*47*	*Ic*	*435 kPa*	*22*	*IIc*	*Stable*
415 kPa	*73*	*-*	*405 kPa*	*36*	*-*	*Limit state*
405 kPa	*>200*	*Id*	*395kPa*	*>200*	*IId*	*Unstable*

In both modeling cases, the holes without internal support pressure were unstable (Figure 1, plots Ib and IIb). The analyses under P_{MUD} = P_W + *ΔP* (where *ΔP ≤ 10% PW*) demonstrated that even minor changes in *ΔP* could be sufficient to alter the hole state from stable to unstable, as summarised below:

- Under PMUD exceeding PW by ca +8-10% very stable to quasi-elastic states are observed (Fig.1, plots Ic and IIc)

- Under PMUD slightly higher (2-3%) than PW limit state conditions were observed. A further minute reduction of PMUD was sufficient to trigger instability.

- Similar analyses of smaller diameter (24'') holes indicated very similar responses with only a small improvement in stability.

The responses are indicative of the sensitivity of the soil materials ability to arch and resist ground loadings to the effective stress-state. Under inadequate internal pressure, yielding of the soil in shear at the sidewalls may trigger tensile failure (hydrofracturing) at the crown (plot Id on Fig. 1).

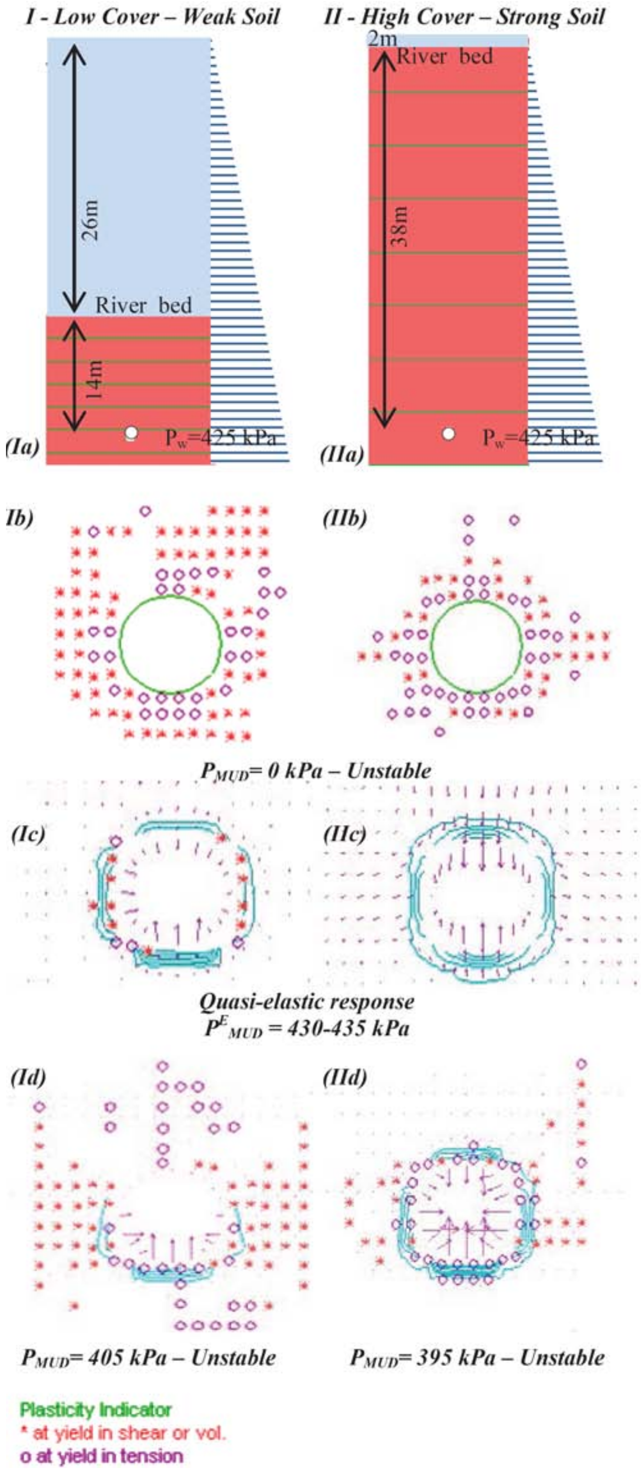


Figure 1 FLAC analyses predicted hole displacement and soil yield states under different internal mud pressures

4.2 PFC Analyses Results

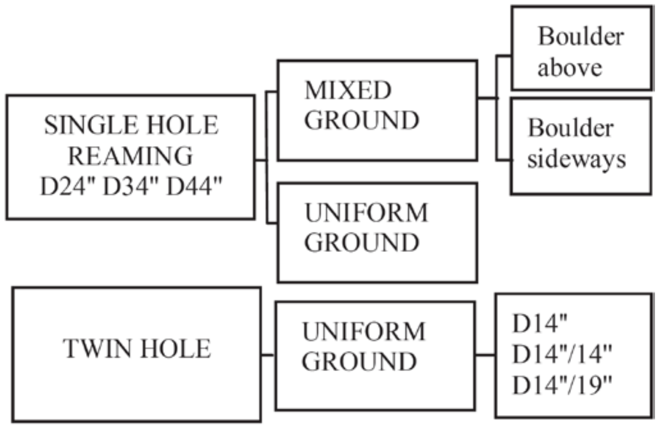
Several practical situations that are encountered in practice were included in the analyses programme, as outlined below:

- Sequential hole enlargement (reaming): A typical construction methodology to form the appropriate diameter for pulling of the pipe. The procedure was simulated in both ‘uniform’ and ‘mixed’ ground conditions.

- Re-drilling of a hole due to accidental discontinuation of a previous attempt. The case was modelled to examine potential interactions between two holes in close proximity and the effects on stability.

The matrix of analyses is presented in Table 6. All PFC simulations assumed weak soil (Table 3) at 14m depth under the river bed and hydrostatic pressure PW=400kPa.

Table 6 Matrix of PFC analyses



4.2.1 Single Hole –Uniform Ground

Stable states were attained for all the simulated hole sizes drilled in a uniform but weak soil matrix under mud overpressure ΔP = 5% PW (Figure 2). Displacements were incremental from ca 13mm up to ca 60mm as the hole diameter increased from 24'' to 44''. In all cases, the hydrostatic pressure was 400 kPa.

4.2.2 Single Hole –Mixed Ground

The presence of a 350mm boulder resulted in significant interference as the distance between the boulder and the hole decreased to≤½D. Notable effects resulted in de-stressing of the intervening soil, reorientation of the soil displacement field and total loss of arching. The resultant effect was formation of shear strain concentrations forming within the intervening soil, excessive soil movements and dislocation of the boulder, all leading ultimately to hole collapse.

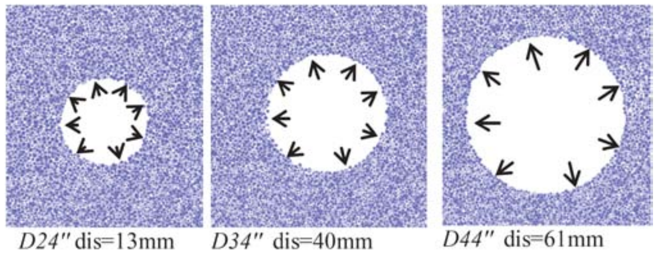


Figure 2 Predicted displacements of stable hole under PMUD=1.05PW at equilibrium during simulated reaming from 24''to 44''

4.2.3 Parallel Holes–Uniform Ground

The modelling case shown on Figure 4 revealed significant interactions during sequential drilling of parallel holes and reaming. Although the distance between the two 12'' holes was several diameters, soil displacements towards the first increased considerably. Reaming of the second hole from 12'' to 20'' mobilised significant displacements over a wide zone, as the intervening weak soil material suffered extensive overstressing. The mechanism progressively extended towards the 12'' hole, which collapsed whilst the 19'' remained at limiting state.

5 CONCLUSIONS

HDD is a method dependant operation relying on stabilisation via partially contaminated mud (i.e. mud and soil component), and relies heavily on a more or less uniform soil state - drill rate interaction. Potential implications of mixed ground conditions include:

- Irregular stress and deformation states around the borehole leading on to stress shadows and loss of arching. As a result, "voiding" and "running" of potentially erodible soil could be initiated from the de-stressed zones. A schematic representation of the mechanism is illustrated on Figure 5.

- Compromised effectiveness of the mud cake sealing process due to non-uniform movements at the hole periphery, where proximity to or contact with boulders occurs.

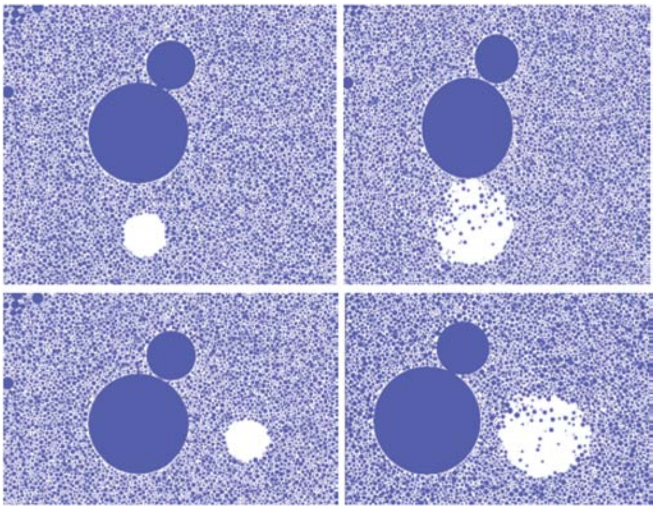


Figure 3 Unstable states predicted when drilling a hole of radius R at distance ≤½R from an obstacle (e.g. boulder). NB: Drilling conditions and soil matrix properties identical to those in Figure 2.

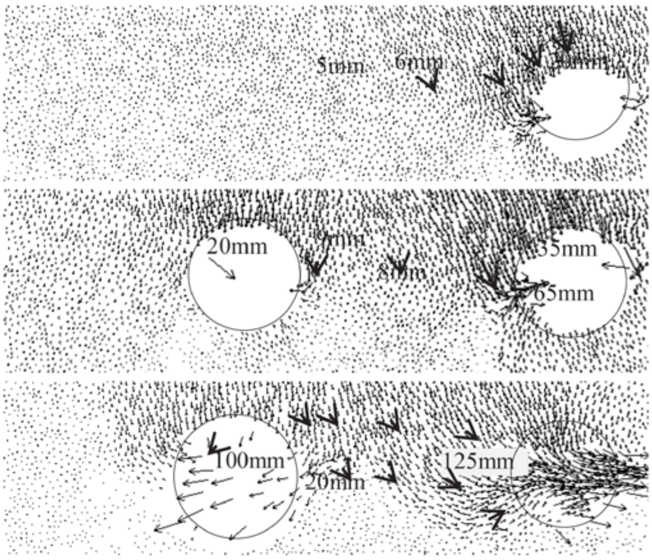


Figure 4 Interactive unstable states of parallel holes in proximity: Top: Stable 12'' single hole; Middle: Stable parallel 12'' holes; convergence of first hole enhanced; Bottom: Collapse of first hole while reaming the second from 12'' to 20''.

Major water courses present a particularly challenging HDD crossing environment due to the dramatic changes of the river course and banks and the rate of sediment deposition resulting in potentially unpredictable soil stratigraphy. For instance, scouring depths up to 30-40m and sediment deposition by 78m in less than 5 years have been observed in deltaic environments. Consequently, borepath design criteria for pipeline protection, such as a cover of 20m below the deepest level of a river, as commonly adopted, may need to be considered carefully.

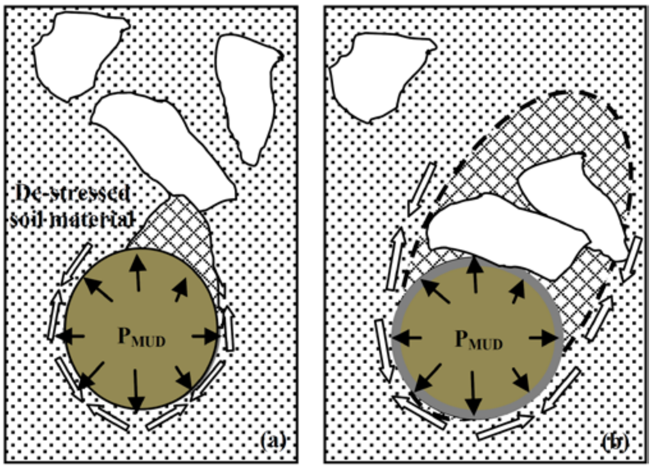


Figure 5 Diagrammatic perception of HDD bore failure mechanism in soil-boulder mixed ground

Designing of HDD crossings of major water courses requires thorough and systematic investigation and evaluation of the ground conditions, notably when 'harder' inclusions within the river bed environment are foreseeable. Nevertheless, it has to be recognised that there is limited technology, in terms of comprehensive investigation methods, that could identify isolated inclusions in these environments.

The applicability of geophysical prospecting methods may be limited, due to the often considerable depth of the water and the isolated occurrence of the obstacles. Significant interference to waterborne geophysics may also arise from increased flow rates and varying water depths. The application of systematic probe drilling is probably the most cost-effective method when investigating mixed ground.

ACKNOWLEDGEMENTS

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Study of a landslide in the residential area of Kastri, North Western Greece, and of the proposed remedial measures

Etude d'un glissement de terrain dans le quartier résidentiel de Kastri, Nord-Ouest de la Grèce, et des Mesures de Protection proposées

M. Bellas and G. Voulgaridis

ABSTRACT This paper refers to the study and treatment of a landslide that occurred in the community of Kastri, belonging to the municipality of Igoumenitsa, found at the region of Epirus in North Western part of Greece. The landslide has affected the Neogene strata consisting of Loamy Sand and Clay of HP with Gravels, into which a temporary superficial aquifer develops, during the heavy winter rainfalls. Underlying this formation compact and impermeable clay with medium plasticity occur, having an average swelling pressure of 100 kPa. Due to the landslide the below concrete retaining wall has developed cracks and has moved downwards. At the same time the downstream courtyards have developed retreat and all 4 maisonettes and 8 apartments of a small block have also exhibit capillary cracks. Initially, a slope stability analysis was executed. In addition, for the confrontation of the landslide the construction of a retaining wall has been proposed, downstream of the houses, consisting of 1m diameter bored piles, penetrating 15m deep, having on top a continuous reinforced headband, with a size of 1.20m X 1.20m. On the reinforced headband the construction of concrete struts has been proposed, having the same number with the piles, and in a way that each strut is over each pile. Upstream of the houses and the above asphalt road, the construction of a drainage trench has been proposed, having depth of about 4.50m, to drain the surface flowing waters, as long as the waters of the temporary shallow aquifer.

1 INTRODUCTION

The landslide phenomena began at the site named "Vrissi" of the village of Kastri during the winter of 2004, after heavy rains, when the first capillary fissures appeared, as well as widened cracks after them. During the year of 2005, several damages occurred including the appearance of cracks in the maisonettes, lowering of their downstream courtyards, large cracks developed on the downstream of a house's retaining wall, as well as hairline cracks were created with openings from to 1-2cm at the paved road above the houses.

Figure 1. Satellite picture from the NW of the Vrissi location, Kastri residence. The red arrow demonstrates the areas where the damages and the landslide occurred.

2 GENERAL GEOLOGY OF THE AREA

In the area of the landslide two boreholes were drilled for research purposes, named ΓΗ-1 and ΓΗ-2, as well as two research trenches, namely OH-1 and OH-2. The depths of these trenches are 3.90m and 2.00m accordingly, while the depth of the boreholes is 30.00m

Figure 2. Boreholes and trenches in the residence of Kastri.

Considering the field research as well as former studies in this area, the geologic structure of the area is given in the form of a stratigraphic column (K. Koukouzas, 1967)

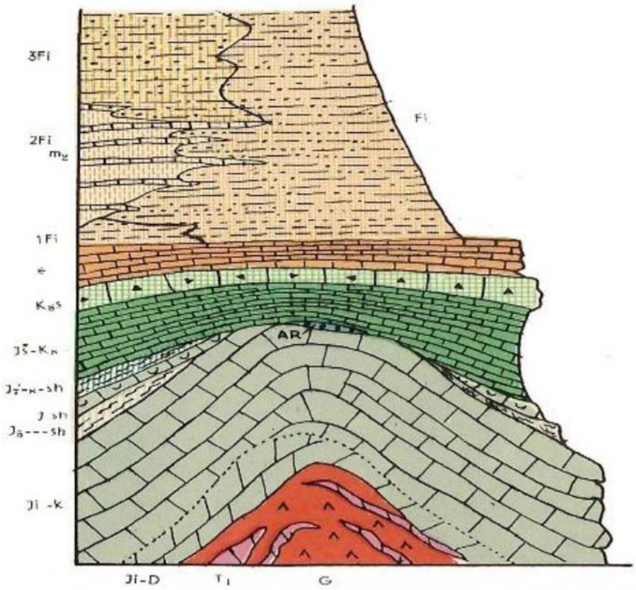

Figure 3. Stratigraphic column of the Kastri area.

Based on their textures from laboratory tests, the formations existing within the first 30m, from upper to lower, are

Table 1. Formations met within 30m of depth

Formation	c (KPa)	φ (degrees)
Loamy Sand	14	33
HP Clay	18	10
LP Clay	100	16
Sandy Gravel	50	25
Silty Clay Loam	130	15
Sandy Gravel	60	25

However, based on field research, the formations affected by the landslide were the upper two surface layers and, more specifically, the Loamy Sand and HP clay layer.

3 RAIN PRECIPITATION

To investigate precipitation the N.M.S. (National Meteorological Service) records of Ioannina station were used, because this station is the nearest to the settlement of

“Kastri”, covering the period between 1956 to 1997. Geographic data of the meteorological station of Ioannina are given in the following table:

Table 2. Geographic data of the N.M.S of Ioannina station

Ioannina Station of N.M.S.	
Latitude	39^0 40’
Longtitude	20^0 51’
Elevation	483.0 m

After the study of the precipitation history, the maximum monthly precipitation height was found to be 250mm.

4 NUMERICAL ANALYSIS OF THE FLOW- DEFORMATION PHENOMENON

As it is well known, landslides occur due to the effect of the groundwater flow on the strength of the geomaterials (reduction of its strength parameters) of which the area's formations are consisted. The coupled flow-deformation phenomenon can mathematically be described as (Li J., Liu X, Jiang Z., 2009)

$$\begin{cases} \sigma_{ij} = \sigma'_{ij} + a(p_w)\delta_{ij} + \vec{F}_v \\ \dfrac{\partial \varepsilon}{\partial t} = n\beta \dfrac{\partial p_w}{\partial t} - \vec{v} \end{cases}$$

where,

σ_{ij}: are the total stresses
σ'_{ij}: are the effective stresses
p_w: are the pore pressures
δ_{ij}: is Kronecker’s Delta
$\vec{F}_v$: is the Force vector
$\vec{v}$: is Darcy’s velocity
ε: is the strain, and
β: is the compressibility of the pore water

For the seepage analysis the Van Genuchten’s model was used, where the Permeability coefficient is given as (Van Genuchten, 1980)

$$K = K_s(\sqrt{S_e}\left[1 - \left(S_e^{\frac{1}{m}}\right)^m\right]^2)$$

where,

K: the Permeability coefficient
K_s: the saturated Permeability coefficient
S_e: the degree of Saturation

5 SOLUTION PROCEDURE USING THE FINITE ELEMENT ALGORITHM

In this paper, the flow-deformation phenomenon along with landslide phenomenon was solved and modeled with the FEM algorithm by using 676 Quadratic Triangular Elements. The solver used for the above analysis was the Gaussian Elimination, whereas the loads, both the rainfall load for the groundwater analysis and the external load from the buildings applied on the slope (R=150 KPa), were applied in incremental load steps. Hence, the systems formed from the analysis of the equations of paragraph 2, according to the Principle of Virtual Work, will have the form

$$[\ K_T\ ]\{\ \Delta u\ \} = \{\ \Delta F\ \}$$

Finally, in order to define the Safety Factor for the stability of the slope, the SSR (Shear Strength Reduction) algorithm was applied.

The mechanical and the hydraulic characteristics of the geomaterials, as well as the hydrogeological characteristics, for which the analysis was performed, are given in the tables below

Table 3. Clay of high plasticity parameters

Parameter	Values
Cohesion (KPa)	18
Internal friction ($Degrees$)	10
Poisson’s ratio	0.32
Unit weight (KN/m^3)	22
Young’s Modulus (KPa)	20000
Permeability coeff. (m/s)	$5.5\text{x}10^{-5}$
Alpha coefficient (a)	0.8
n coefficient	1.09

Table 4. Loamy Sand parameters

Parameter	Values
Cohesion (KPa)	14
Internal friction ($Degrees$)	33
Poisson’s ratio	0.25
Unit weight (KN/m^3)	20
Young’s Modulus (KPa)	15000
Permeability coeff. (m/s)	$4\text{x}10^{-5}$
Alpha coefficient (a)	12.4
n coefficient	2.28

Table 5. Hydrogeological characteristics of the area

Hydrogeological parameters	Values
Rainfall inflow Q (m/s)	$8.6\text{x}10^{-8}$

Initially, we perform an analysis in our whole domain in order to check which areas in our domain have the highest stress concentration. With the use of a plane strain FEM analysis for finding the slip surface in our whole domain, we observe that the stress concentration is described as in the picture below

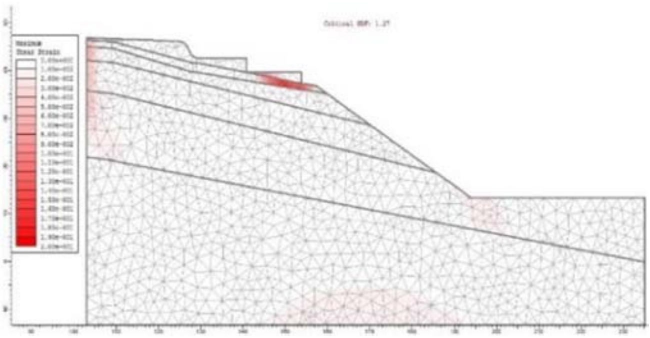

Figure 4. FEM analysis of the whole domain.

Considering the above areas of actual high concentration, we narrow our coupled seepage-deformation analysis within this dangerous area of high stress concentration

Taking account all the above data, we perform a 27-day transient seepage analysis of a total 250mm of water precipitation, and we obtain the following results

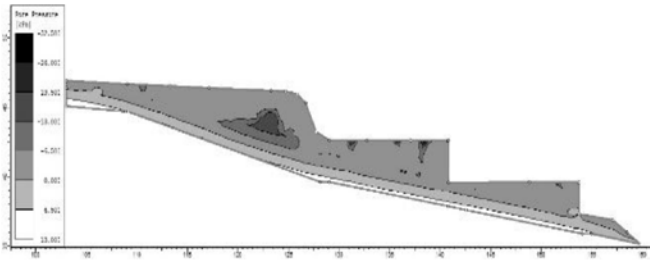

Figure 5. Groundwater regime during 1 day of rainfall.

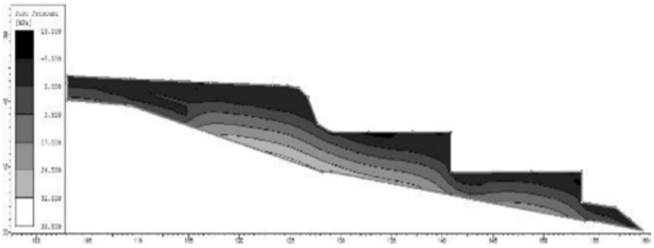

Figure 6. Groundwater regime during 3 days of rainfall.

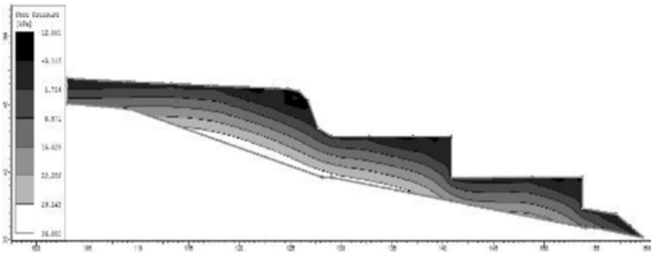

Figure 7. Groundwater regime during 12 days of rainfall.

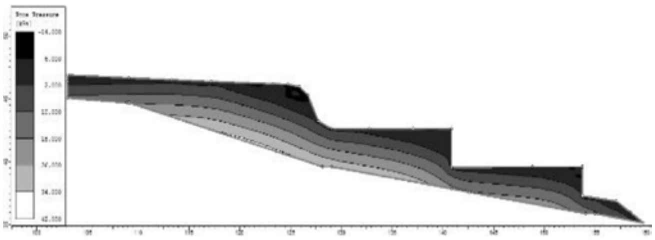

Figure 8. Groundwater regime during 15 days of rainfall.

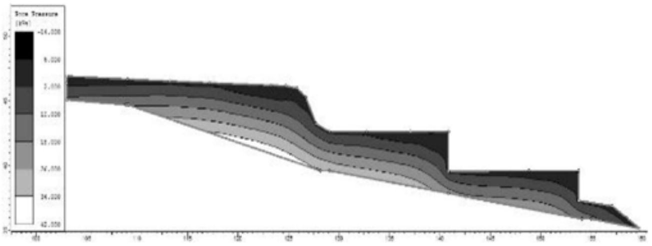

Figure 9. Groundwater regime during 27 days of rainfall.

After obtaining the pore pressures, we perform a coupled soil-groundwater interaction analysis along with the SSR algorithm by taking into account the external loading, and we end up to the following results

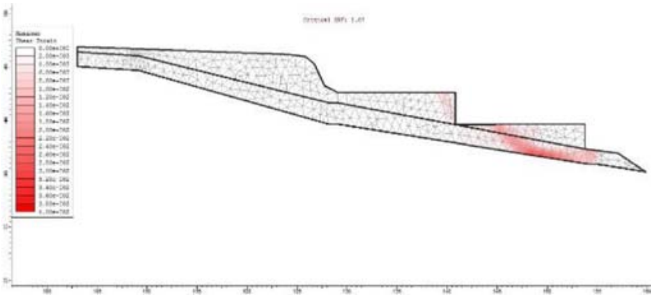

Figure 10. Displacement regime and slip surface during the first day. The SF is 1.07.

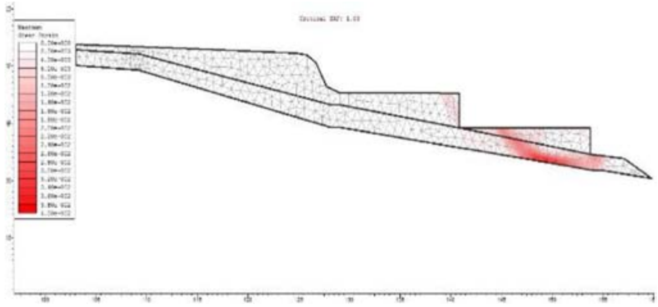

Figure 11. Displacement regime and slip surface during the 3rd day. The SF is 1.03.

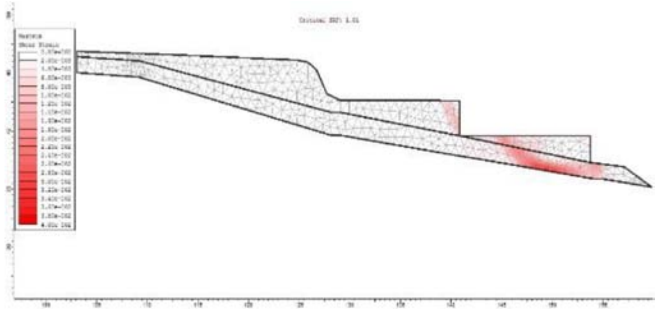

Figure 12. Displacement regime and slip surface during the 12th day. The SF is 1.01.

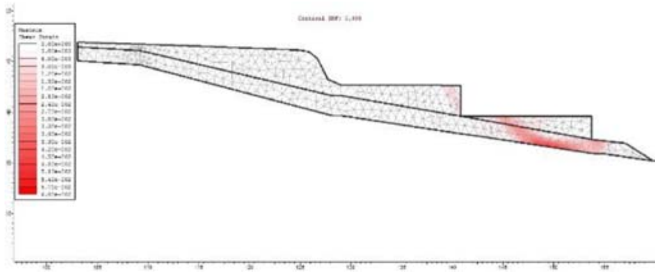

Figure 13. Displacement regime and slip surface during the 15th day. The SF is 0.995.

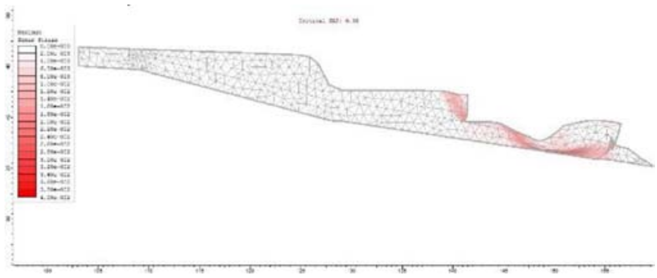

Figure 14. Displacement regime and slip surface during the 27th day. The SF is 0.98 and the deformation is as modeled as described.

6 REMEDIAL MEASURES

For the protection of the houses a single retaining wall had to be constructed. The assumptions for this specific support are:

- The slope is considered having a morphological inclination of 25°.
- The retaining wall will retain an open excavation of 6m depth. The assumption was made in order to predict future movements of soil mass.
- The slope exerts additional permanent loads, due to the existence of the houses of about 30 kN /m^2, which apply

after 5m distance from the retaining wall and up to 15m from it. The depth of loads application is -1.50m from the free surface.

- The horizontal component of seismic acceleration coefficient is 0.24g and the vertical component is 0.07g.
- The proposed solution considers non intersecting piles of 1.00m diameter and axial spacing of 1.50m.
- The solution is made with the programs WALL & WALL DIMENTIONING according to Eurocode 2.

The proposals for the prevention of any further movements of soil masses due to the examined landslides are:

1. Construction of a drainage ditch in the upstream (inner) side of the paved road, which passes over the affected houses. Its width should be 0.90m, and its depth 3.50m.
2. Construction of retaining wall consisting of 49 bored piles with diameter Φ1000mm (1m). The bored piles will have axial spacing 1.50m and the depth of each pile should be 15 meters below the level of the downstream cementitious road, (level 0.0 should be considered the position of the research trench OH-2. The concrete piles will contain 20Φ22mm iron bars as vertical reinforcement and iron hoops of Φ10/10cm as shear reinforcement. The concrete piles will be joined by a 1.20m X 1.20m perimeter beam (headband) to achieve static unification. Above the headband, in place of each pile, equal number of buttresses will be constructed having dimensions 0.60m X 1.80m X 0.30m and width of 0.60m.

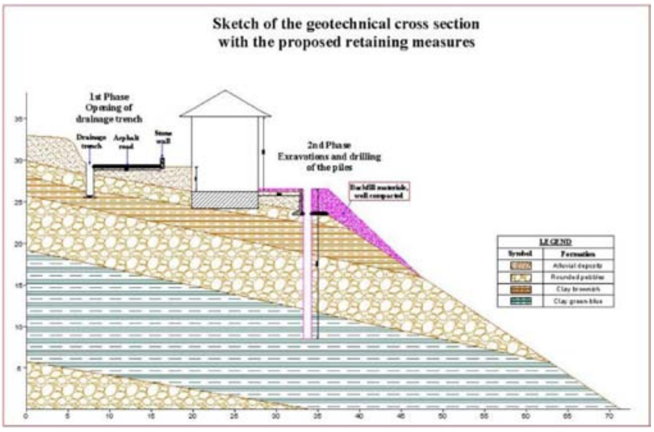

Figure 15. Geotechnical cross section with the proposed retaining measures

CONCLUSIONS

Taking into account the results obtained by the analysis, the Safety Factor underwent a significant reduction in terms of the slope's stability. The slope falls into an unstable condition (SF<1) after 15 days of constant rainfall. However, due to the fact that the analysis conducted for 27 days gave a safety factor within the range of 1 - 0.98, the formations affected perform a creeping phenomenon instead of an immediate landslide from the 15th day and on. In addition, by the analysis performed, it is confirmed that the failed formations that undergo creeping are indeed the first two layers.

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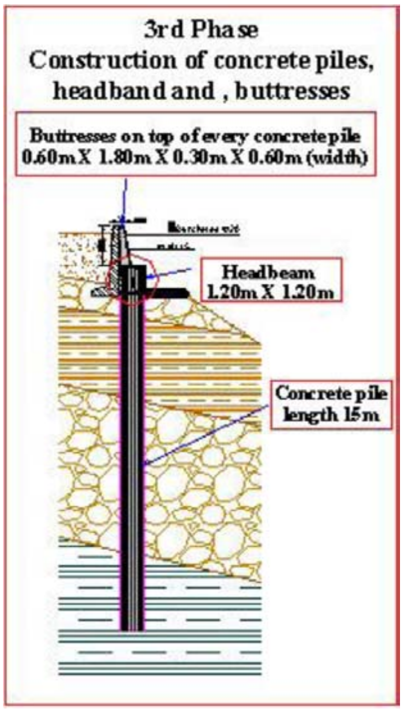

Figure 16. Construction of the concrete piles

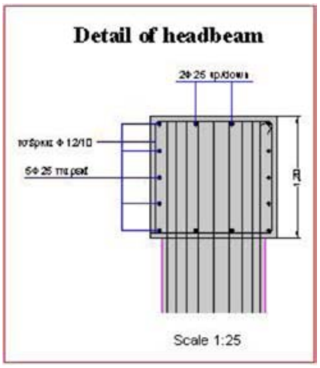

Figure 17. Detail of the headbeam

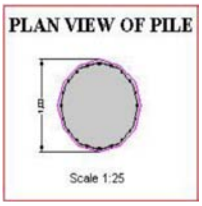

Figure 18. Plan view of the piles

K. Koukouzas, 1967. Geological Map of Greece, sheet of Philliates, scale 1:50000, IGME publishing, Acharnai

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Correlating the residual strength to index properties

Corréler la résistance résiduelle de propriétés d'index

G. Belokas

ABSTRACT The residual strength, which corresponds to the ultimate shear strength, is mobilized along a slip surface due to large shear deformation and is described by the residual angle of shearing resistance (φ_r) and the residual cohesion (c_r). In common geotechnical engineering practice the residual strength failure envelope is assumed linear with c_r=0. The laboratory determined residual strength from reconstituted or remoulded soil samples is an intrinsic property. While intrinsic compressibility has been found to correlate well with Atterberg Limits, the same is not completely true for the residual strength. There have been various proposals concerning residual strength, yet most of them seem to have a considerable scatter. This is exhibited herein by comparing these empirical correlations to existing and new experimental data. It is concluded that a single parameter correlation cannot be used for the residual strength yet it can give a broad trend. The present work attempts to use the Atterberg Limits (LL, PI) and grain indices (e.g. CF), which reflect to microstructural characteristics, to correlate residual strength and it is found that this approach may reduce the scattering of the data. The above indices reflect the dependence of residual strength on grain size distribution and mineralogy of soils. As all correlations, the proposed correlation should be used cautiously and only for preliminary calculations and for planning the laboratory testing program.

1 INTRODUCTION

The residual strength (c_r', φ_r') corresponds to a strength mobilized along a slip surface that undergoes large strains (see Bishop, 1971; Bishop et al, 1971; Lupini et al, 1981, Tika et al, 1996) and is the minimum strength that a soil can develop (Figure 1, Mohr - Coulomb envelopes). This post – peak strength is typically mobilized along presheared surfaces, i.e. surfaces that have experienced large shear displacements in the past, which, in practice, correspond mostly to reactivated landslides mobilize. While intrinsic compressibility has been found to correlate well with Atterberg Limits (e.g. Burland, 1990, Belokas & Kavvadas, 2011), the same is not completely true for the residual strength. Yet, there have been various proposals concerning residual strength (e.g. Voight, 1973, Cancelli, 1977, Stark & Eid, 1994)

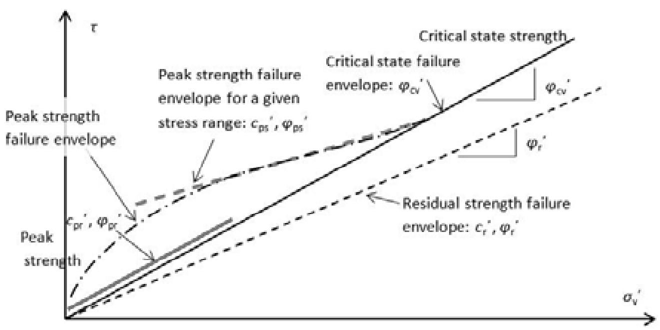


Figure 1. Review of the Mohr – Coulomb failure envelopes for design purposes in soil mechanics. (Anagnostopoulos & Belokas, 2012)

2 STRENGTH FOR LIMIT STATE ANALYSIS

For first time slides, Skempton (1970) introduced the concept of "fully softened strength" (c_s', φ_s'). It can be concluded that: a) for non-fissured stiff clays it is $\varphi_s' \approx \varphi_{ps}'$ to $\varphi_s' \approx \varphi_{cv}'$, while there can be an appreciable component of cohesion and b) for fissured stiff clays it is $\varphi_s' \approx \varphi_{cv}'$. The $\varphi_s' \approx \varphi_{cv}'$ is the "fully softened state". All these have also been thoroughly discussed by Anagnostopoulos & Belokas (2012).

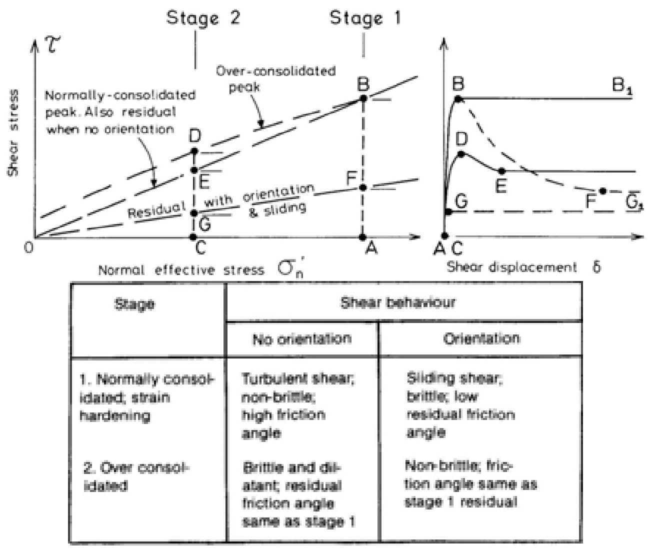
For clayey soils, the residual strength condition, φ_r, corresponds to oriented platy particles along the slip movement. It generally is $\varphi_s' \geq \varphi_r'$ and the difference between φ_s' and φ_r' (Mesri & Shahien, 2003): a) approaches zero at very low plasticity, where particle reorientation is not a factor, b) maximizes at a plasticity index around 50% and c) becomes constant at very high plasticity, where the predominant particle interaction even for a random fabric is face to face (Mesri & Cepeda – Diaz, 1986). Mesri & Shahien (2003) give some empirical relationships about the secant angles of shearing resistance.

3 RESIDUAL STRENGTH

The slow residual strength, which is usually determined in conventional engineering practice, is best estimated from ring shear apparatus but reversal shear box tests can also be used. Bishop et al (1971) report that ring shear apparatus gives lower φ_r values. Equivalent results to the ring shear device can also be given by the cut-thin sample technique in the direct shear box (Skempas, 1994). Skempton (1985) and Popescu (1998), summarizing φ_r' values from different test methods report that:

- Direct shear tests on slide plane or bedding plane shear are the most reliable indicator of field residual strength.
- Ring shear devices either underestimate by 1° to 2° or approximate the field residual.
- Multiple reversal direct shear on clays will probably overestimate field residual by 1° to 2°.

Although it is typically assumed that $c_r' \approx 0$, there is some evidence that a small cohesion intercept can be present as c_r can vary from 0 to 8kPa (see Lupini et al, 1981). This could also be the effect of the nonlinear relationship of φ_r' with the normal stress (e.g. Bishop et al, 1971; Kaltetziotis, 1993; Mesri, M. Shahien, 2003, Stark & Eid, 1994). An effect usually ignored for most practical engineering and design purposes but also in the present study. Lupini et al (1981), based on experimental evidence, proposed the ideal stress – strain response of Figure 2.



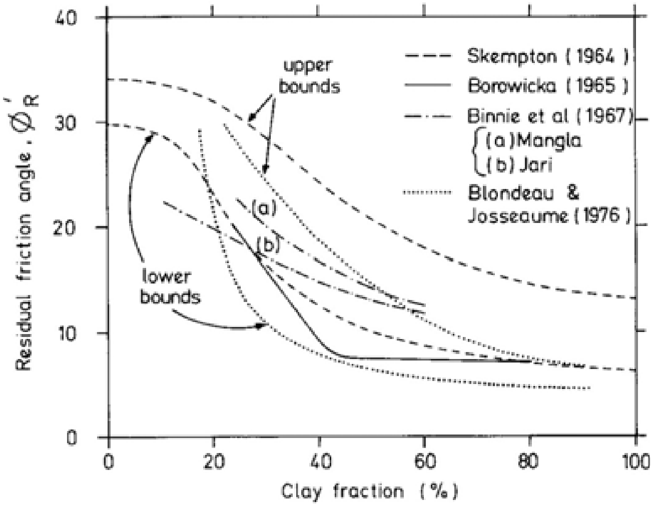
Stage	Shear behaviour	
	No orientation	Orientation
1. Normally consolidated; strain hardening	Turbulent shear; non-brittle; high friction angle	Sliding shear; brittle; low residual friction angle
2. Over consolidated	Brittle and dilatant; residual friction angle same as stage 1	Non-brittle; friction angle same as stage 1 residual

Figure 2. Idealized residual behavior according to the ring shear test. (Lupini et al, 1981)

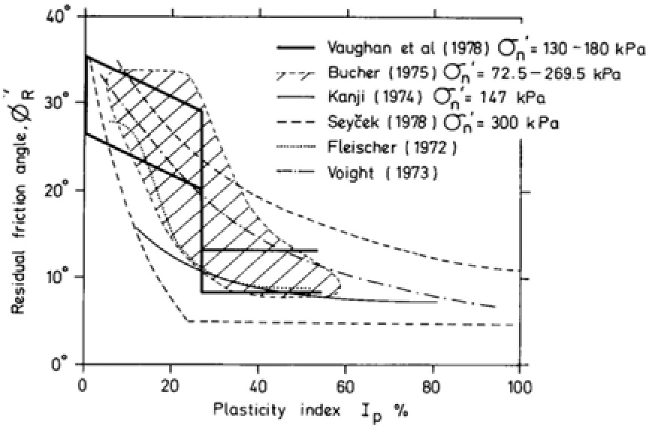
4 RESIDUAL STRENGTH AS INTRINSIC PROPERTY

Residual strength is independent of soil's previous stress history or any structure. Therefore, mineralogy, grain size and shape, the angle of interparticle friction, φ_μ, control the mode of shearing and affect the corresponding mobilized residual strength (Lupini et al, 1981; Skempton, 1964; Tsiambaos, 1991; Tsifoutidis, 1993). These microstructural factors could be described by index properties such as Atterberg Limits, clay fraction (CF) and the fines fraction (No 200 passing), as well as their resulting indices (e.g. clay activity A=PI/CF).

Experimental results (Bishop et al, 1971; Kaltetziotis, 1991, Mesri & Cepeda-Diaz, Skempton, 1964; Stark & Eid, 1994, Tsifoutidis, 1993) show that for high plasticity clays with PI≥40% or CF≥40% the residual angle of shearing resistance can be as low as 10^o, even a bit lower (e.g. Figure 3). This is due to the sliding shear mechanism. In particular, Lupini et al (0) report that for natural clayey soils it is $\varphi_r' \approx 5^o$ to 20^o. It is interesting, that in design practice this trend is mentioned in BS 6301:2009 "Code of Practice for Earthworks".



(a)



(b)

Figure 3. Residual strength as a function of a) CF and b) I_p. (Lupini et al, 1981)

5 A REVIEW OF EXISTING CORRELATIONS

Although residual shear strength is considered to be an intrinsic property there appears to exist a great scattering when plotting this strength with respect to the commonly used index properties of soils. For instance Figure 4 shows the data from Stark & Eid (1994).

Corellations of the φ_r to the clay minerals content have been proven to be less successful than corellations to the Atterberg limits and/or grain size content (e.g. Tsiambaos, 1991; Tsifoutidis, 1993). Tsiambaos (1988, 1991) proposed Equation 1 for the secant $\varphi_{r,sec}$ of the white-yellow brown-yellow Irakleion marls with I_p up to 30%, without taking into account the vertical stress. He found stronger relationship with I_p (eq. rather than the ratio PL/LL), while he attributed the relatively high values of $\varphi_{r,sec}$ to the micrite content of non-clayey minerals (e.g. CaCO3, quartz) that prohibit the reorientation of the clayey particles). According to the author's experience, this also happens when there are fossil residues within the material, even if the material appears to be of high plasticity. Therefore, one has to be careful to those residues.

$$\tan\varphi_{r,sec} = -0.1201\log I_p + 0.934 \qquad (1)$$

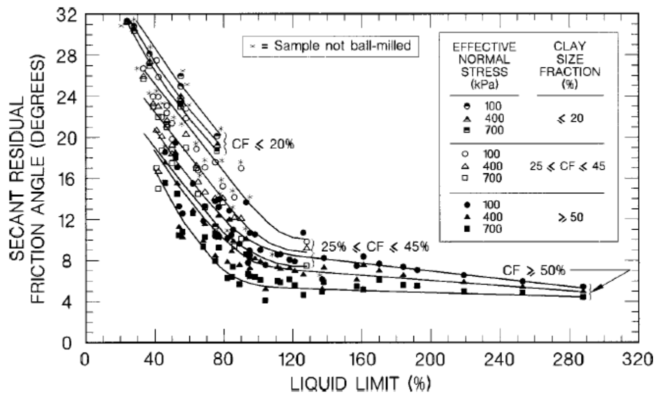


Figure 4. Residual strength as a function of CF and LL. (Stark & Eid, 1994; Stark et al, 2005)

There are correlations based on Atterberg Limits: a) I_p as equation 2 by Voight (1973; Kanji, 1974, proposed a=0.466 and b=46.6), b) w_L as equation 3 by Cancelli (1997).

$$\varphi_r = b/(I_p)^a \qquad (2)$$

$$\varphi_r = 453.1(w_L)^{-0.85} = b(w_L)^{-a} \qquad (3)$$

A rather complex approach is that of Tsifoutidis (1993), which takes into account the complete gradation of the finer to sand fraction (Equation 4).

$$\varphi_{res} = b_o + b_1 (e^{CF} / e^{sand}) + b_2 (CF\cdot sand) + b_3 (fsilt)/(csilt) + b_4 (csilt)^2 / (sand)^2 + b_5 (msilt) / (sand)^2 + b_6 (CF)^2 / (sand)^2 + b_7 (msilt) / (csilt) \qquad (4)$$

where CF is the clay fraction, fsilt the fine silt, msilt the medium silt, csilt the coarse silt, b_o=38.05, b_1=18.45, b_2=-142.4, b_3=-1.057, b_4=-6.739·10^{-2}, b_5=5.69·10^{-2}, b_6=-6.739·10^{-2} and b_7=1.196.

Collota et al (1989) proposed Equation (5), which correlates residual strength as to clay fraction, liquid limit and plasticity index.

$$\varphi_r = f(CALIP), \text{ where } CALIP=(CF)^2\cdot w_L\cdot I_p\cdot 10^{-5} \qquad (5)$$

Wright (2005), based on Stark & Eid (1994) graphs, proposed Equation (6), which correlates secant residual strength to liquid limit and vertical stress.

$$\varphi_{r,sec} = 52.5^o-21.3^o\cdot\log10(w_{LL})-3\cdot\log_{10}(\sigma_f'/p_a) \qquad (6)$$

When speaking for one value of the φ_r, then it is assumed to the result of the best fit on all data assuming a linear strength envelope, while when speaking for the secant $\varphi_{r,sec}$, then it is pressure dependent and it takes into account the non-linearity of the strength envelope.

6 APPLICATION AND INVESTIGATION OF CORRELATIONS TO EXPERIMENTAL DATA

The above correlations will be now applied to a collection of experimental data. The experimental data used come from:

a) Kaltetziotis (1991) for Hellenic marls, b) Delwookar & Huzjak (2005) for Colorado Claystones, c) Stark & Eid (1994) for soils from various landslides, d) unpublished data on Hellenic soils from Western Macedonia. Where necessary, the data were reworked to give c_r=0kPa and φ_r.

The trend proposed by Stark et al (2005) with respect to LL is compared to the data from Kaltetziotis (1991) in Figure 5. The trends presented by Lupini et al (1981) are compared to experimental data from various authors in Figures 6 and 7. Figure 8 depicts the measured values versus the predicted by Equations 2 to 3. Equation 2 with the constants proposed by Kanji (1974) exhibited a poor correlation. On the other hand, equation 4 requires considerable information to be applied, which is not available. With respect to Equation 5 the available data do seem to have any correlation. Concerning Equations 1 and 6 these correspond to secant φ_r.

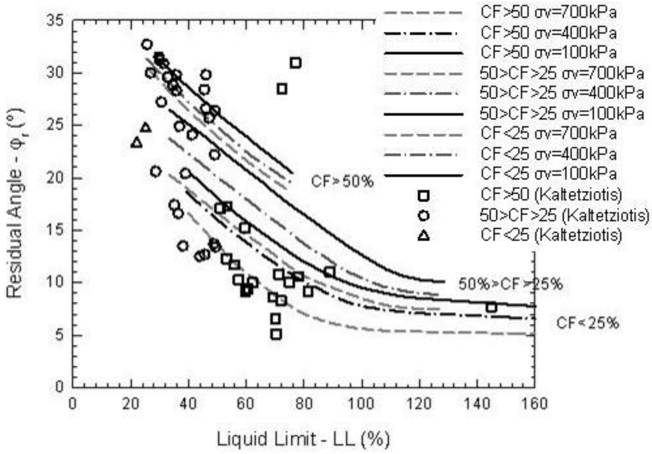


Figure 5. Residual strength of Hellenic soils (data by Kaltetziotis, 1991) superimposed to Stark et al (2005) trends.

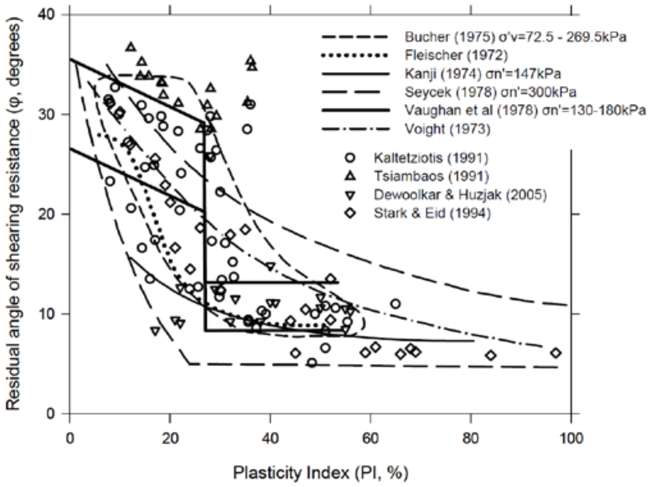


Figure 6. Residual strength versus plasticity index for various materials (graph based on Lupini et al, 1981).

Equations 2 and 3 are now being re-examined to better predict the collected experimental data. A regression analysis for Equation 2 leads to a=0.693 and b=157, while for Equation 3 leads to a=-0.986 and b=770.96, which result to Figure 9. The improvement is obvious for Voight's equation.

In the following, an attempt is presented to correlate the residual angle of shearing resistance to more than one index measure. Two different series of statistical analyses were performed.

The first series included a function of the form of Equation 7, which is linearized into Equation 8, with x_i=LL, PL, PI, CF, PI/CF, LL/PL, $e_{LL}=G_s \cdot LL$, $e_{PL}=G_s \cdot PL$, $e_{PI}=G_s \cdot PI$ and a, b_i the corresponding constants.

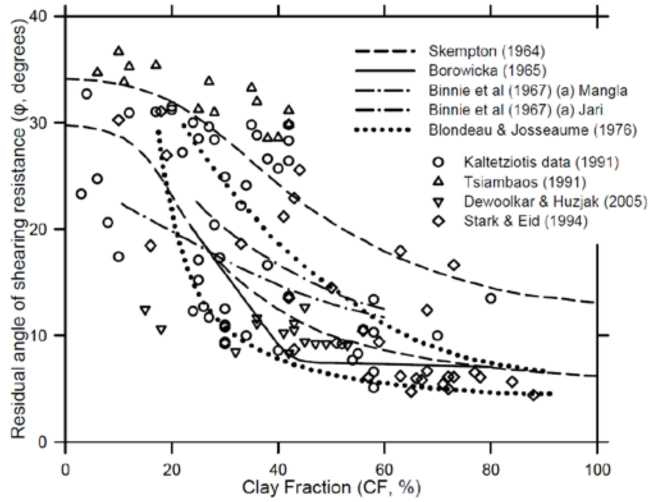


Figure 7. Residual strength versus clay fraction for various materials (graph based on Lupini et al, 1981).

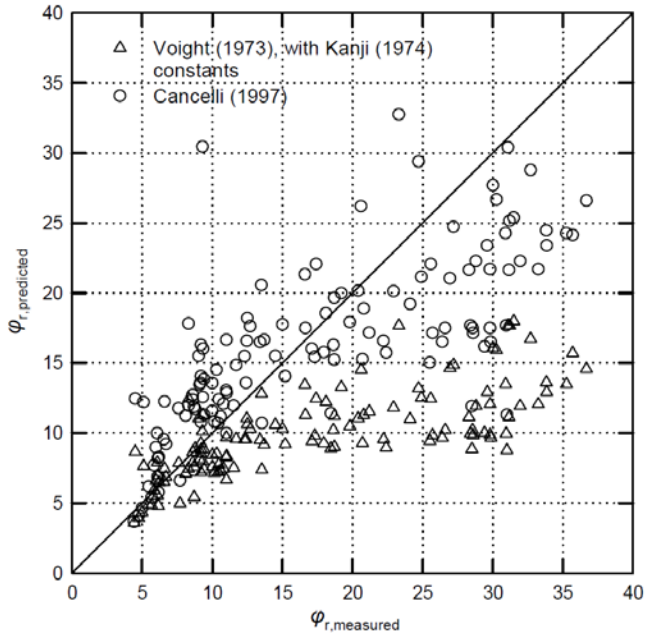


Figure 8. Measured values versus predicted by Equations 2 and 3.

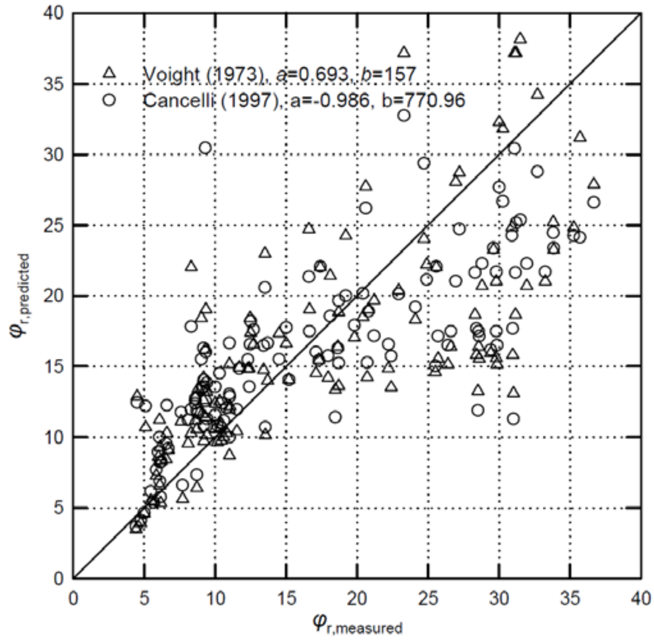


Figure 9. Measured values versus predicted by Equations 2 and 3 – re-evaluation of correlation constants.

$$\varphi = \alpha \cdot x_1^{b1} \cdot x_2^{b2} \cdot \ldots x_k^{bk} \quad (7)$$

$$\ln\varphi = \ln\alpha + b_1 \ln x_1 + b_2 \ln x_2 + \ldots + b_k \ln x_k \quad (8)$$

The resulting relationship is Equation 10 with constants a=5.6343, b_1=-0.5711, b_2=0.0306, b_3=0.0725, b_4=-0.2268. Figure 10 compares the measured to the predicted residual angle of shearing resistance for the various materials examined.

$$\varphi = \alpha \cdot PI^{b1} \cdot (PI / CF)^{b2} \cdot LL^{b3} \cdot PL^{b4} \quad (10)$$

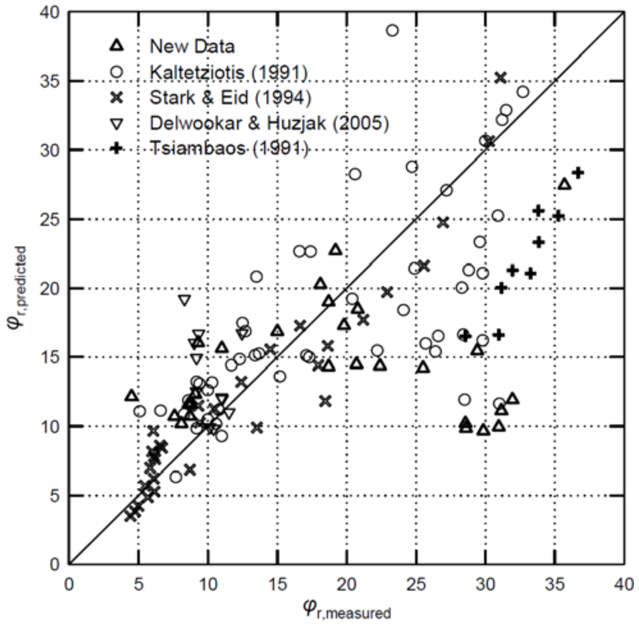


Figure 10. Measured values versus predicted by Equation 10.

The second series included a power function of various linear combinations of the index properties measures, which resulted to Equation 11, where α=195.82 and b=-1.739. Figure 11 compares the measured to the predicted residual angle of shearing resistance for the various materials examined.

$$\varphi = \alpha \cdot PI \cdot [PI + (CF / PI)]^{b} \quad (11)$$

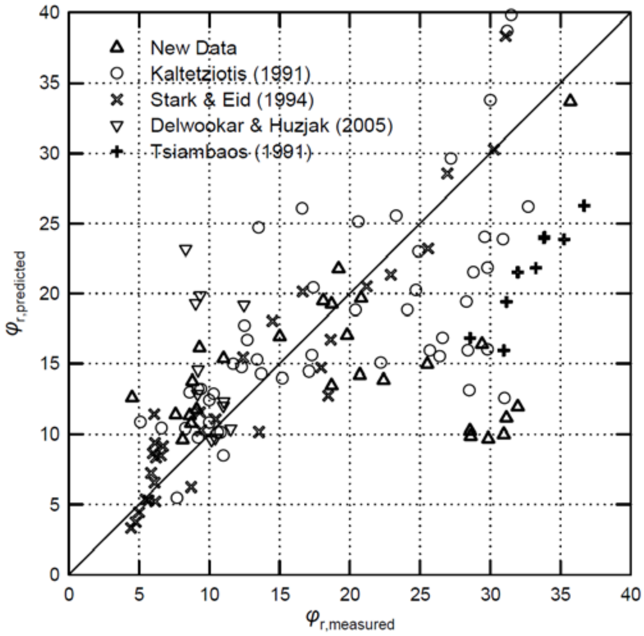


Figure 11. Comparison of the measured values to the predicted ones by Equation 11.

In Figures 10 and 11 it is obvious that the data of Stark & Eid (1994) present the best fit. There still is a significant portion of underpredicted residual angles of shearing resistance, yet this may be attributed to the presence of non-clayey minerals that prohibit the reorientation of the clayey particles (see Tsiambaos, 1991). However, there seems to be a better treatment for the overpredicted angles.

7 CONCLUSIONS

The estimation of the residual angle of shearing resistance from index properties, which relate to soil microstructural characteristics, was examined. A reevaluation of the constants for the existing empirical equations of Voight (1973) and Cancelli (1991) improves their predictive capabilities. More complex equations such as Equation 10 may slightly improve prediction. It seems that the presence of non-clayey minerals can have a profound effect, which was not taken into account, leading to underpredicted values. Approaches, similar to but simpler than Tsifoutidis (1993), that take into account the complete microstructural characteristics of soils, have to be explored.

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ΝΕΑ ΑΠΟ ΕΛΛΗΝΙΚΕΣ ΚΑΙ ΔΙΕΘΝΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΝΩΣΕΙΣ

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Βράβευση άρθρου των Απόστολου Βράκα και Γεωργίου Αναγνώστου από το Institution of Civil Engineers του Ηνωμένου Βασιλείου

Κάθε χρόνο ο εκδοτικός οίκος του ICE βραβεύει τους συγγραφείς των καλύτερων άρθρων που δημοσιεύθηκαν στα περιοδικά του ICE. Βραβεύονται συγγραφείς τόσο από την βιομηχανία όσο και από τα πανεπιστήμια, που έχουν παράξει έργο εξαιρετικής ποιότητας και προς όφελος των έργων πολιτικού μηχανικού, της κατασκευής και της επιστήμης των υλικών.

Το βραβείο *Geotechnical Research Medal* για δημοσίευση στο περιοδικό Géotechnique έλαβαν οι **Απόστολος Βράκας** και **Γεώργιος Αναγνώστου** για το άρθρο τους "A simple equation for obtaining finite strain solutions from small strain analyses of tunnels with very large convergences".

Ο Απόστολος Βράκας είναι απόφοιτος του ΕΜΠ και εκπονεί την διδακτορική διατριβή του στο ETH Zurich. Ο Γεώργιος Αναγνώστου είναι καθηγητής στο ETH Zurich, Institute for Geotechnical Engineering (IGT), Chair of Underground Construction.

Διαλέξεις Ηλία Μιχάλη στα Ηνωμένα Αραβικά Εμιράτα

Το μέλος της ΕΕΕΕΓΜ προσεκλήθη από το παράρτημα του Institution of Civil Engineers του Ηνωμένου Βασιλείου στα Ηνωμένα Αραβικά Εμιράτα και παρουσίασε διάλεξη με θέμα τις εσωτερικές επενδύσεις σηράγγων, στο Abu Dhabi, στις 24 Μαΐου 2016 και στο Dubai, στις 25 Μαΐου 2016. Στη συνέχεια παρατίθεται η σχετική πρόσκληση που απέστειλε το ICE.

Dear Colleagues

With summer well underway, I would like to take the opportunity to look back at an exciting few months of activities with the UAE Graduate & Student Committee.
...
Monthly Learned Events continue to attract a large number of industry professionals and we were fortunate to host Ilias Michalis, Associate Technical Director, Arcadis in May who gave an exceptional lecture on Tunnel Lining Design & Applications.
...
Have a great summer!

Max Steele
ICE & UAE Graduate & Student Representative

Συνύπαρξη (ειρηνική) Q (Nick Barton) & GSI (Παύλος Μαρίνος)!!!

Έργο Uma Oya, στον θάλαμο των στροβίλων

Χαιρετίσματα από Sri Lanka

Παύλος Μαρίνος

ΕΛΛΗΝΙΚΕΣ ΤΕΧΝΟΛΟΓΙΚΕΣ ΕΞΕΛΙΞΕΙΣ ΣΤΗΝ ΓΕΩΜΗΧΑΝΙΚΗ κ.α.

Τεχνικές Αερο-υπηρεσίες για Υποδομές

Αγαπητοί συνάδελφοι,

Με ευχαρίστηση βλέπουμε το ιδιαίτερο ενδιαφέρον που έχει δείξει ο τεχνικός κόσμος για τις υπηρεσίες των drones σε τεχνικές εφαρμογές καταγραφής τεχνικών έργων, τρισδιάστατων αποτυπώσεων και χαρτογραφήσεων του φυσικού και τεχνητού περιβάλλοντος.

Τους τελευταίους 6 μήνες έχουμε αποτυπώσει για διαφορετικές τεχνικές εφαρμογές πάνω από 10 km^2 στον Ελλαδικό χώρο, αλλά και στο εξωτερικό. Με την εμπειρία που έχουμε αποκομίσει και την προσφορά μας στον τεχνικό και ερευνητικό κόσμο από την εκτέλεση συγκεκριμένων εφαρμογών ελπίζουμε ότι αναδεικνύονται με τον πλέον εμφανή τρόπο, τα οφέλη χρήσης των drones όσον αφορά στην αμεσότητα, ακρίβεια και ταχύτητα λήψης φωτογραφικών δεδομένων τα οποία με την κατάλληλη τεχνική επεξεργασία τροφοδοτούν τις αντίστοιχες μελέτες / ερευνητικά προγράμματα με πολύτιμα μετρητικά ψηφιακά προϊόντα υψηλής ακρίβειας και πιστότητας.

Επιθυμώντας να συμβαδίζουμε με τις εξελίξεις και να πρωτοστατούμε στην εφαρμογή και προώθησή τους, θεωρήσαμε ότι θα σας ενδιαφέρει να σας κοινοποιήσουμε ένα μέρος των εργασιών που έχουμε πραγματοποιήσει το τελευταίο διάστημα.

Σας προσκαλούμε να επικοινωνήσετε μαζί μας αν θέλετε να διερευνήσετε την πιθανή χρησιμότητα αυτών των εργαλείων στην εργασία σας.

Με φιλικούς χαιρετισμούς,

Γιάννης Μανουσάκης, Τοπογράφος Μηχανικός, MSc Γεωπληροφορική-GIS
Δημήτρης Ζέκκος, Γεωτεχνικός Πολιτικός Μηχανικός, Αναπληρωτής Καθηγητής του University of Michigan, Επισκέπτης Καθηγητής στο Εθνικό Μετσόβιο Πολυτεχνείο

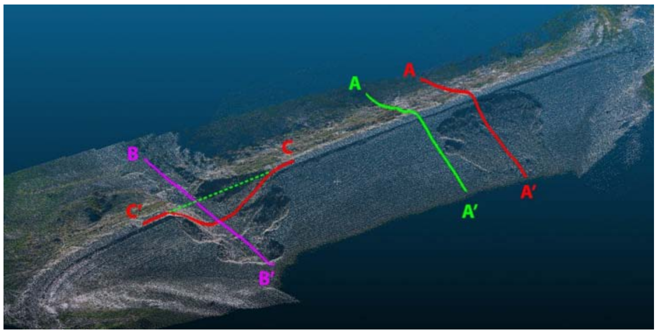
Παραδείγματα προσφάτων εφαρμογών της ELXIS GROUP Ιανουάριος - Μάιος 2016

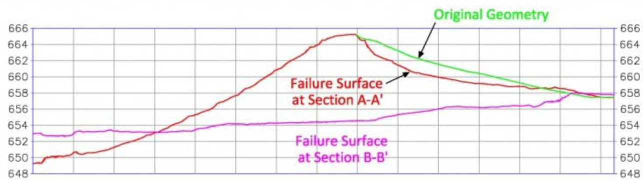
Κατάρρευση του φράγματος του ταμιευτήρα Σπαρμού, κάμπος Ελασσόνας, 27 Μαρτίου 2016.

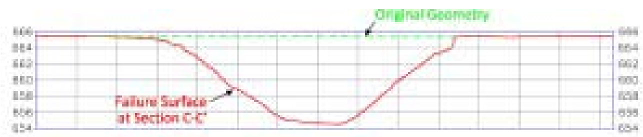
- Δημιουργία τρισδιάστατου μοντέλου του φράγματος.
- Γραμμικά σχέδια κατά μήκος και εγκάρσιων τομών στις δύο αστοχίες.

Τα αντανακλαστικά της ELXISGROUP και η αμεσότητα που προσφέρει η χρήση των drones σε διαδικασίες χαρτογράφησης και τρισδιάστατης αποτύπωσης δυσπρόσιτων περιοχών δοκιμάστηκαν με επιτυχία για ακόμη μία φορά κατά την επίσκεψη του επιτελείου μας στον κάμπο της Ελασσόνας, δύο ημέρες μετά την κατάρρευση του φράγματος του ταμιευτήρα Σπαρμού στους πρόποδες του Ολύμπου που σημειώθηκε στις 27 Μαρτίου 2016. Βίντεο από αέρος με αποσπάσματα από την αυτοψία 4 ωρών που διενεργήσαμε με το drone μπορείτε να παρακολουθήσετε στον ακόλουθο σύνδεσμο: Sparmos Dam Failure Drone Video.

Μεγάλο ενδιαφέρον παρουσιάζουν τα αποτελέσματα της έρευνάς μας από τις επί τόπου παρατηρήσεις στο ύψους 15 μέτρων φράγμα σε συνδυασμό με τα χαρτογραφικά δεδομένα και τις τρισδιάστατες απεικονίσεις που παρήχθησαν κατόπιν επεξεργασίας του φωτογραφικού υλικού που συλλέξαμε.







Η αστοχία οφείλεται καθαρά σε υπόγεια ροή (underseepage and piping) και όχι υπερχείλιση overtopping όπως είχε δημοσιοποιηθεί. Η κατάντη πλευρά του φράγματος είναι γεμάτη τοπικές αστοχίες, μετακινήσεις και φέρει ενδείξεις διάβρωσης της επιφάνειας του φράγματος! Άκρως εντυπωσιακή ως προς τη εκδήλωσή της, ήταν και η δευτερεύουσα αστοχία η οποία πραγματοποιήθηκε κατά την ταχεία πτώση της στάθμης του νερού του ταμιευτήρα (rapid drawdown failure).

Η δημιουργία του τρισδιάστατου μοντέλου του φράγματος με ψηφιακές φωτογραμμετρικές μεθόδους σε πραγματική κλίμακα μας επέτρεψε να διεξάγουμε μετρήσεις ακριβείας σε κατά μήκος και εγκάρσιες τομές στις δύο αστοχίες. Στις απεικονίσεις αριστερά, διακρίνεται το νέφος τρισδιάστατων σημείων (3D Point Cloud) που αναπαριστά την επιφάνεια του φράγματος και του περιβάλλοντος χώρου καθώς και τα ίχνη των τομών που εξετάστηκαν. Μπορείτε, επίσης, να χειριστείτε εικονικά το τρισδιάστατο μοντέλο του φράγματος και να παρατηρήσετε λεπτομέρειες στη γεωμετρία και την υφή του στο σύνδεσμο που ακολουθεί: Sparmos Dam Failure 3D Model.

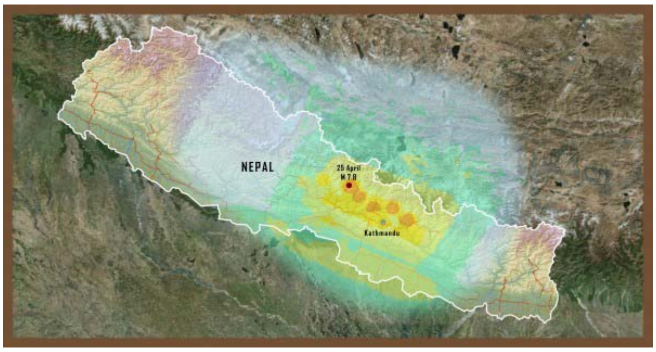
Στην ακόλουθη αντιπαραβολή πραγματικής φωτογραφίας και τρισδιάστατου νέφους σημείων του μοντέλου του φράγματος παρατηρεί κανείς τη λεπτομέρεια της απεικόνισης που μεταφέρεται πλέον σε ψηφιακό περιβάλλον για τις ανάγκες καταγραφής και ανάλυσης του φαινομένου.

Παραθέτουμε, επίσης και ορισμένα σημαντικά μετρητικά τεχνικά χαρακτηριστικά του φράγματος και τις ευρύτερης πληγήσας περιοχής όπως προέκυψαν από την ανάλυση του τρισδιάστατου μοντέλου του φράγματος και του παραγόμενου ορθοφωτοχάρτη.

- Όγκος νερού που απελευθερώθηκε κατά την εκκένωση του ταμιευτήρα: ~ 85000 κυβικά μέτρα
- Επιφάνεια πλημμύρας: ~ 100 στρέμματα

Για την εξάρτηση του μοντέλου και την παραγωγή του ορθοφωτοχάρτη μετρήθηκαν δεκαοκτώ (18) φωτοσταθερά με RTK GPS, έξι (6) εκ των οποίων χρησιμοποιήθηκαν για την εκτίμηση του σφάλματος του μοντέλου (μέσο σφάλμα ±2.5 εκατοστά).

Χρήση Drones για τη χαρτογράφηση κατολισθήσεων από το σεισμό Gorkha 2015 στο Νεπάλ



Στις 25 του Απριλίου 2015, ένας σεισμός μεγέθους 7,8 έπληξε το Νεπάλ, σκοτώνοντας περισσότερους από 8.000 ανθρώπους και εκτοπίζοντας εκατομμύρια. Κατά τη διάρκεια και αμέσως μετά την ισχυρή δόνηση, σχεδόν 20.000 κατολισθήσεις ενεργοποιήθηκαν στο κρημνώδες ορεινό ανάγλυφο των Ιμαλαΐων. Αυτές οι κατολισθήσεις προκάλεσαν άμεσες ανθρώπινες και υλικές απώλειες και συνεχίζουν να αποτελούν μία διαρκή απειλή ως συνέπεια αυτού του καταστροφικού σεισμού. Αποψιλωμένες πλαγιές που εκτέθηκαν από κατολισθήσεις κατά τη διάρκεια της σεισμικής δόνησης, αστόχησαν εκ νέου υπό την εκδήλωση θανατηφόρων λασπορούν που προκλήθηκαν κατά τη διάρκεια της εποχής των βροχών των μουσώνων μόλις το περασμένο καλοκαίρι.

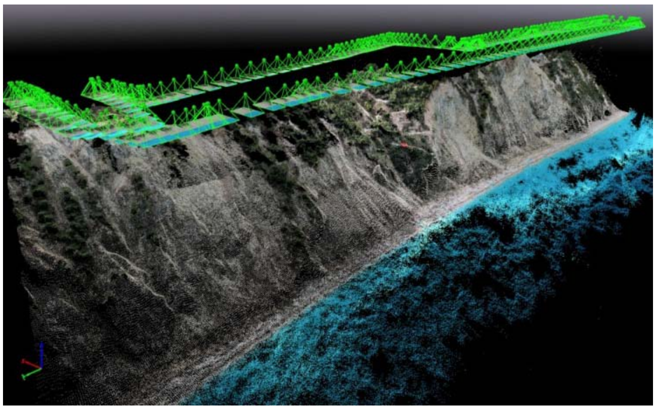
Τον Οκτώβριο του 2015, ομάδα ερευνητών από πανεπιστήμια της Αμερικής και του Νεπάλ με επικεφαλής τους καθηγητές Δημήτριο Ζέκκο (University of Michigan, USA), Marin Clark (University of Michigan, USA), Joshua West (University of Southern California, USA) και Deepak Chamlagain (Tribhuvan University, Nepal), ηγήθηκαν της αποστολής επίσκεψης στις πληγείσες περιοχές του Νεπάλ με στόχο την καταγραφή/αποτύπωση με σύγχρονα πτητικά μέσα (drones) χαρακτηριστικών κατολισθήσεων που ενεργοποιήθηκαν κατά τη διάρκεια και αμέσως μετά την ισχυρή δόνηση. Με τη χρήση των drones, η επιστημονική ομάδα κατάφερε να συλλέξει σε σύντομο χρονικό διάστημα μεγάλο όγκο πολύτιμων δεδομένων από παρατηρήσεις σε δυσπρόσιτες περιοχές με λήψη αεροφωτογραφιών και αερο-βιντεοσκοπήσεων πολλαπλών εναέριων γωνίων θέασης.

Συνεργάτες της εταιρείας μας συμμετείχαν στην επεξεργασία μέρους του φωτογραφικού υλικού με εξειδικευμένο λογισμικό ψηφιακής φωτογραμμετρίας, και συνέβαλε ουσιαστικά στη διαδικασία εξαγωγής μετρητικών πληροφοριών από τρισδιάστατα νέφη σημείων (3D Point Clouds) μέσω της δημιουργίας ψηφιακών μοντέλων εδάφους και ορθοφωτοχαρτών.

Συγκριτικές απεικονίσεις (Νοεμβρίου 2015 - Απριλίου 2016) περιοχών κατολισθήσεων

Ο σεισμός της 17ης Νοεμβρίου 2015 προκάλεσε σημαντικές κατολισθήσεις σε μεγάλο τμήμα της δυτικής Λευκάδας. Από τις ομορφότερες παραλίες του νησιού, οι Εγκρεμνοί, γέμισαν με κατολισθητικές αποθέσεις. Τα μέσα μαζικής επικοινωνίας και δικτύωσης δημοσίευαν άρθρα ότι χάθηκε μια από τις ομορφότερες παραλίες του νησιού και της Μεσογείου.

Στελέχη της εταιρείας μας βρέθηκαν στο νησί δυο μόνο εικοσιτετράωρα μετά το σεισμό. Με τη χρήση drone, μπορέσαμε να καταγράψουμε την καταστροφή που είχε προκληθεί (δείτε video εδώ). Σε συνεργασία με ερευνητική ομάδα του University of Michigan, του Εθνικού Μετσόβιου Πολυτεχνείου και του Πανεπιστημίου Πατρών, αποτυπώσαμε εκ νέου τις κατολισθήσεις στις 12 Απριλίου 2016, δηλαδή σχεδόν πέντε μήνες μετά. Μέρος των χαρτογραφημένων εκτάσεων παρουσιάζεται στην απεικόνιση που ακολουθεί.



Σχέδιο πτήσης και τρισδιάστατο νέφος σημείων

Όπως διαπιστώνεται στη συγκριτική φωτογραφία που ακολουθεί, οι παραλίες, σε μεγάλο βαθμό έχουν ήδη «καθαρίσει» με τη δράση φυσικών διεργασιών. Φυσικά, ο δρόμος που οδηγεί στην παραλία έχει υποστεί μεγάλες ζημιές και παραμένει κλειστός. Αντίστοιχα, συγκριτικό drone video από τις 2 περιόδους μπορείτε να παρακολουθήσετε στον ακόλουθο σύνδεσμο: [Comparative Drone Video Footage – Lefkada Earthquake Nov 2015 VS Apr 2016]

Συγκριτική απεικόνιση παραλίας Εγκρεμνών, Νοέμβριος 2015 – Απρίλιος 2016

Τρισδιάστατη αποτύπωση κατεστραμένου καμπαναριού στα Κουρουκλάτα Κεφαλληνίας με φωτογραφικό υλικό από drone

Στις 23 Μαΐου 2016 πραγματοποιήσαμε αυτοψία με drone σε κατεστραμμένο καμπαναριό ύψους 25 μέτρων που είχε υποστεί εκτεταμένες ζημιές από το σεισμό του 2014 στο χωριό Κουρουκλάτα Κεφαλληνίας και παραμένει σε αυτή τη δυσμενή και επικίνδυνη για τους κατοίκους και τους επισκέπτες κατάσταση έως και σήμερα.

Ο σκοπός της εργασίας μας αφορά στη δημιουργία ενός τρισδιάστατου υποβάθρου σε πραγματική κλίμακα για χρήση από ειδικούς μελετητές που θα εκτιμήσουν με σύγχρονα μέσα το μέγεθος και τη φύση των καταστροφών και θα αποκτήσουν πρόσβαση σε φωτογραφικό υλικό εναέριων λήψεων που δύσκολα θα μπορούσαν να καταγράψουν με επίγεια μέσα.

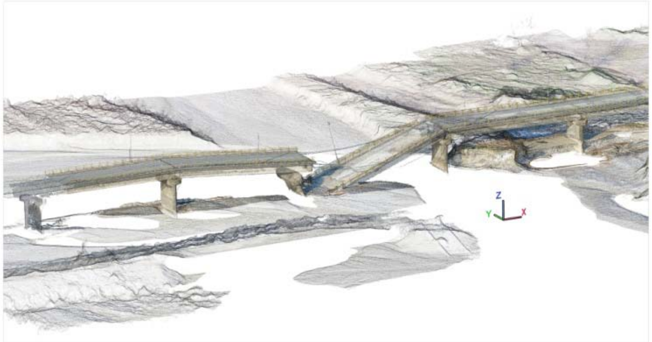
Τρισδιάστατη αποτύπωση της γέφυρας της Διάβας μετά από κατάρρευση λόγω υποσκαφής

Το βράδυ της 16ης Ιανουάριου 2016 κατέρρευσε η γέφυρα της Διάβας, η οποία διασχίζει τον Πηνειό ποταμό κοντά στην πόλη της Καλαμπάκας. Η κατάρρευση της γέφυρας πραγματοποιήθηκε κατά τη διάρκεια κακοκαιρίας, και οφείλεται στην υποσκαφή ενός υποστυλώματος, η οποία οδήγησε στην μετακίνηση, καθίζηση και στροφή του υποστυλώματος, και σε επακόλουθη πτώση του υποστηριζόμενου καταστρώματος της γέφυρας.

Όπως παρατηρείται στην πανοραμική φωτογραφία από το drone, και άλλα υποστυλώματα έχουν μερικώς υποσκαφθεί και ενδέχεται να απειλούνται.

Η ELXIS GROUP πραγματοποίησε μια επι-τόπου αποτύπωση της κατάστασης της γέφυρας στις 21 Ιανουαρίου. Η θέση της αστοχίας ήταν απροσπέλαστη καθώς η γέφυρα ήταν αποκλεισμένη στο κοινό, ενώ τα νερά του Πηνειού δεν επέτρεπαν την προσέγγιση στο σημείο της αστοχίας. Η χρήση drone επέτρεψε την αποτύπωση με μεγάλη ακρίβεια της παραμορφωμένης κατάστασης της γέφυρας από απόσταση ασφαλείας με λήψη αεροφωτογραφιών υψηλής ανάλυσης από διαφορετικές γωνίες θέασης (649 φωτογραφίες κατακόρυφων, πλάγιων και οριζόντιων όψεων του αντικειμένου).

Η δημιουργία του τρισδιάστατου μοντέλου της γέφυρας με φωτογραμμετρικές μεθόδους σε πραγματική κλίμακα μας επέτρεψε να διεξάγουμε μετρήσεις ακριβείας μετακινήσεων και στροφών που υπέστη το υποστύλωμα και ο φορέας της γέφυρας. Στις εικόνες που ακολουθούν διακρίνεται το νέφος τρισδιάστατων σημείων (3D Point Cloud) που αναπαριστά την πολύπλοκη επιφάνεια των στοιχείων της γέφυρας και του περιβάλλοντος χώρου καθώς και τα τρισδιάστατα στερεά που προσομοιώνουν τα υποστυλώματα της γέφυρας.



Δείτε παραδείγματα εφαρμογών στους ακόλουθους κλάδους:

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Στοιχεία επικοινωνίας

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(Σημείωση Εκδότη: Η παραπάνω καταχώρηση είναι σαφώς διαφημιστική. Διαφημίζει, όμως, ένα πρωτοποριακό προϊόν, δημιουργημένο από Έλληνες Πολιτικούς Μηχανικούς, το ο-ποίο αξίζει να το προβάλουμε.)

ΤΑ 10 ΠΡΩΤΑ ...

Top 10 Papers in ...

The purpose of this session is to provide to any interested engineer or company a starting point of the best publications on a specific topic. Qualified and well-known Professors or engineers are invited to recommend the best 10 papers in a specific field of their expertise.

Top ten papers on Surface Wave Analysis for Geotechnical Site Characterization

Suggested by Professor Sebastiano Foti, Politecnico di Turin, Italy. List compiled in March 2013.

- Jones R.B. 1958. In-situ measurement of the dynamic properties of soil by vibration methods. Geotechnique, 8 (1), 1-21
- Nazarian S., Stokoe II K.H. 1984. In situ shear wave velocities from spectral analysis of surface waves. Proc. 8th Conf. on Earthquake Eng. - S.Francisco, Prentice-Hall, 3, 31-38
- Gabriels P., Snieder R., Nolet G. 1987. In situ measurements of shear-wave velocity in sediments with higher-mode Rayleigh waves. Geophys. Prospect., 35, 187-196
- Stokoe K.H. II, Wright S.G., J.A. Bay, J.M. Roesset. 1994. Characterization of geotechnical sites by SASW method", Geophysical Characterization of Sites (ISSMFE TC#10) by R.D. Woods, Oxford & IBH Publ., pp. 15-25
- Tokimatsu K. 1995. Geotechnical Site Characterisation using Surface Waves. Proc. 1st Int. Conf. on Earth. Geotechn. Eng., IS-Tokio IS Tokyo 1995, Balkema, 1333-1368
- Luke, B. A., and K. H. Stokoe. 1998. Application of SASW method underwater. J. of Geotechn. Geoenvironm. Eng., 124, 523-531
- Park C.B., Miller R.D., Xia J. 1999. Multichannel analysis of surface waves. Geophysics, 64, 800-808
- Lai C.G., Rix G.J., Foti S., Roma V. 2002. Simultaneous Measurement and Inversion of Surface Wave Dispersion and Attenuation Curves. Soil Dynamics and Earthquake Eng., 22 (9-12), 923-930
- Foti S., Comina C., Boiero D., Socco L.V. 2009 Non uniqueness in surface wave inversion and consequences on seismic site response analyses, Soil Dynamics and Earthquake Eng., Vol. 29 (6), 982-993
- Tran, K. and Hiltunen, D. 2012. Two-Dimensional Inversion of Full Waveforms Using Simulated Annealing. J. Geotech. Geoenviron. Eng., 138(9), 1075–1090.

Top ten papers on the Flat Dilatometer

Suggested by Professor Marchetti S., Professor, Department of Civil Engineering, L' Aquila University, Italy. List compiled in January 2003.

- Technical Committee TC16 (2001) "The DMT in Soil Investigations". A Report by ISSMGE's TC16, 41 pp.
- ASTM D6635-01 (2002) "Standard Test Method for Performing the Flat Plate Dilatometer". Book of Standards Vol. 04.09, 15 pp.
- Eurocode 7, (1997) "Geotechnical Design. Part 3: Design assisted by field tests, Flat Dilatometer Test (DMT)".
- Marchetti S. (2002) "The Flat dilatometer". Lecture at 3rd Croatian Conf. On Soil Mechanics and Geot. Engineering, Hvar, 36 pp.
- Marchetti, S. (1980) "In Situ Tests by Flat Dilatometer". Journal of the Geotechn. Engineering Division, ASCE, Vol. 106, No. GT3, Proc. Paper 15290, pp. 299-321.
- Totani, Calabrese, Monaco (1998)."In situ determination of Ch by Flat Dilatometer (DMT)". Proc. First Intnl Conf. on Site Characterization ISC '98, Atlanta, Georgia (USA), pp. 883-888.
- Robertson, P.K., Davies, M.P. & Campanella, R.G. (1987) "Design of Laterally Loaded Driven Piles Using the Flat Plate Dilatometer". Geotechn. Testing Jnl, Vol. 12, No. 1: pp. 30-38.
- Schmertmann, J.H.et al.(1986) "CPT/DMT Quality Control of Ground Modification at a Power Plant". Proc. In situ '86 ASCE Spec. Conf. Virginia Tech, Blacksburg, VA, pp. 985-1001.
- Reyna, F. & Chameau, J.L. (1991) "Dilatometer Based Liquefaction Potential of Sites in the Imperial Valley". 2nd Int. Conf. on Recent Advances in Geot. Earthquake Engrg. and Soil Dyn. St. Louis. May, 7 pp.
- Iwasaki K. et. al (1991) "Applicability of the Marchetti Dilatometer Test to Soft Ground in Japan". GEOCOAST '91, Sept. 1991, Yokohama 1/6, 4 pp.

Top ten papers on the properties of Municipal Solid-Waste

Suggested by Dr. Kavazanjian, E., and Dr. Matasovic, N. , Geosyntec Consultants, Huntington Beach, CA, USA. List compiled in March 2003.

- Augello, A.J., Matasovic, N. Bray, J.D., Kavazanjian, E., Jr., and Seed, R.B. (1995), “Evaluation of Solid Waste Landfill Performance During the Northridge Earthquake,” In: Earthquake Design and Performance of Solid Waste Landfills, ASCE Geotechnical Special Publication No. 54, pp. 17-50.
- Dixon, N., Jones, D.R.V., and Whittle, R.W. (1999), “Mechanical Properties of Household Waste: In Situ Assessment Using Pressuremeters,” Proc. Sardinia ‘99 - 7th International Waste Management and Landfill Symposium, Cagliari, Italy, Vol. III, pp. 453-460.
- Eid, H.T., Stark, T.D., Evans, W.D., and Sherry, P.E. (2000), “Municipal Solid Waste Slope Failure: Waste and Foundation Soil Properties,” Journal of Geotechnical and Geoenvironmental Engineering, ASCE. Vol. 126, No. 5, pp. 397-407.
- Fassett, J., Leonards, G., and Reppeto, P. (1994), “Geotechnical Properties of Municipal Solid Waste and Their Use in Landfill Design,” Proc. Waste Tech ’94, Solid Waste Association of North America, Silver Springs, Maryland, pp. 1-31.
- Hendron, D.M., Fernandez, G., Prommer, P.J., Giroud, J.P., and Orozco, L.F. (1999), “Investigation of the Cause of the 27 September 1997 Slope Failure at the Dona Juana Landfill,” Proc. Sardinia ‘99 - 7th International Waste Management and Landfill Symposium, Cagliari, Italy, Vol. III, pp. 545-567.
- Kavazanjian, E., Jr. (2001), “Mechanical Properties of Municipal Solid Waste,” Proc. Sardinia ‘01 - 8th Interna-

tional Waste Management and Landfill Symposium, Cagliari, Italy, October, Vol. III, pp. 415-424.

- Landva, A.O. and Clark, J.I. (1990), "Geotechnics of Waste Fill," Geotechnics of Waste Fills – Theory and Practice, STP 1070, ASTM, Philadelphia, Pennsylvania.
- Landva, A.O., Valsangkar, A.J. and Pelkey, S.G. (2000), "Lateral Earth Pressure at Rest and Compressibility of Municipal Solid Waste," Canadian Geotechnical Journal, Vol. 37, pp. 1157-1165.
- Matasovic, N. and Kavazanjian, E., Jr. (1998), "Cyclic Characterization of OII Landfill Solid Waste," Journal of Geotechnical and Geoenvironmental Engineering, ASCE, Vol. 124, No. 3, pp. 197-210.
- Mitchell, J.K. (1996), "Geotechnics of Soil-Waste Material Interactions," 2nd International Congress Environmental Geotechnics, Osaka, Japan. A.A. Balkema, Vol. 3, pp. 1311-1328.

ADDITIONAL READING ON MSW PROPERTIES (IN ALPHABETICAL ORDER)

- Idriss, I.M., Fiegel., G., Hudson, M.B., Mundy, P.K. and Herzig, R. (1995), "Seismic Response of the Operating Industries Landfill," In: Earthquake Design and Performance of Solid Waste Landfills, ASCE Geotechnical Special Publication No. 54, pp. 83-118.
- Kavazanjian, E. Jr., Hendron, D. and Corcoran, G.T. (2001), "Strength and Stability of Bioreactor Landfills," Proc. 6th Annual Landfill Symposium, Solid Waste Association of North America, Silver Springs, Maryland, 18-20 June, San Diego, pp. 63-72.
- Kavazanjian, E. Jr., and Matasovic, N. (2001), "Seismic Design of Mixed and Hazardous Waste Landfills," State of the Art Paper No. 11, Proc. 4th International Conference on Recent Advances in Geotechnical Earthquake Engineering, University of Missouri, Rolla, 27-31 March, San Diego, California, on CD ROM.
- Kavazanjian, E., Jr., Matasovic, N. and Bachus, R.C. (1999), "Large-Diameter Static and Cyclic Laboratory Testing of Municipal Solid Waste," Proc. Sardinia '99 - 7th International Waste Management and Landfill Symposium, Cagliari, Italy, October, Vol. III, pp. 437-444.
- Kavazanjian, E., Jr., Matasovic, N., Stokoe, K.H., II, and Bray, J.D. (1996), "In-Situ Shear Wave Velocity of Solid Waste from Surface Wave Measurements," Proc. 2nd International Congress Environmental Geotechnics, Osaka, Japan, A.A. Balkema, Vol. 1, pp. 97-104.
- Kavazanjian, E., Jr., Matasovic, N. Bonaparte, R. and Schmertmann, G.R. (1995), "Evaluation of MSW Properties for Seismic Analysis," In: Geoenvironment 2000, ASCE Geotechnical Special Publication No. 46, Vol. 2, pp. 1126.
- Matasovic, N., Williamson, T.A. and Bachus, R.C. (1998), "Cyclic Direct Simple Shear of OII Landfill Solid Waste," Proc. 11th European Conference on Soil Mechanics and Foundation Engineering, Porec, Croatia. Vol. 1, pp. 441-448.

Top ten papers on the Cone Penetration Test

Suggested by Professor Paul W. Mayne, Department of Civil & Environmental Engineering, Georgia Institute of Technology. List compiled in May 2003.

- Campanella, R.G. and Robertson, P.K. (1988), "Current status of the piezocone test", Penetration Testing 1988, Vol. 1 (Proc. ISOPT-1, Orlando), Balkema, Rotterdam, 93-116.
- Jamiolkowski, M., Ladd, C.C., Germaine, J. and Lancellotta, R. (1985), "New developments in field and lab testing of soils", Proceedings, 11th Intl. Conference on Soil Mechanics and Foundations Engineering, Vol. 1, San Francisco, 57-154.
- Lunne, T., Lacasse, S., and Rad, N.S. (1994). "General report: CPT, PMT, and recent developments in in-situ testing." Proceedings, 12th ICSMFE, Vol. 4, Rio de Janeiro, 2339-2403.
- Mayne, P.W. (1991). "Determination of OCR in clays by piezocone tests using cavity expansion and critical state concepts." Soils and Foundations, Vol. 31 (2), 65-76
- Powell, J.J.K., Quarterman, R.S.T. and Lunne, T. (1988). "Interpretation and use of the piezocone test in UK clays", Penetration Testing in the UK, Thomas Telford, London, 151-156.
- Robertson, P.K. and Campanella, R.G. (1983). "Interpretation of cone penetration tests: sands and clays". Canadian Geotechnical Journal, Vol. 20 (4), 719-745.
- Robertson, P.K. (1990). "Soil classification using the cone penetration test". Canadian Geotechnical Journal 27 (1), 151-158.
- Senneset, K., Sandven, R. and Janbu, N. (1989). "Evaluation of soil parameters from piezocone tests". Transportation Research Record 1235, National Academy Press, Washington, DC, 24-37.
- Teh, C.I. and Houlsby, G.T. (1991). "An analytical study of the cone penetration test in clay". Geotechnique 41 (1), 17-34.
- Wroth, C.P. (1984). "The interpretation of in-situ soil tests". (The 24th Rankine Lecture). Geotechnique 34 (4), 449-489.

Top ten Introductory Papers on Macroscopic Soil Plasticity Constitutive Modelling

Suggested by Professor Y.F. Dafalias, Department of Civil and Environmental Engineering, University of California at Davis, CA, USA, and Department of Mechanics, National Technical University of Athens, Hellas. List compiled in December 2003.

List compiled in December 2003

The following list of 10 introductory papers is recommended for the beginner reader of macroscopic soil plasticity constitutive modeling, based on the simplicity and initiation of concepts. Many (and more recent) papers presenting models of greater simulative capabilities are not included, because they are formulated at a higher level of complexity, appropriate for advanced reading. Also, micromechanically based contributions were not considered in this list.

- Drucker, D.C., R.E. Gibson and D.J. Henkel. (1955). "Soil Mechanics and Work-Hardening Theories of Plasticity". Proceedings, ASCE, Vol. 81, pp. 1-14.
- Roscoe, K.H., A.N. Schofield and D.P. Wroth. (1958). "On the Yielding of Soils". Geotechnique, Vol. 9, pp. 22-53.
- Roscoe, K.H. and J.B. Burland. (1968). "On the Generalized Stress-Strain Behavior of Wet Clay". Engineering Plasticity, pp. 535-609.
- DiMaggio, F.L. and I.S. Sandler. (1971). "Material Models for Granular Soils". J. Eng. Mech. Div., ASCE, 97(EM3):935-950.

- Lade, P.V.and Duncan J.M. (1975). "Elastoplastic Stress-Strain Theory for Cohesionless Soil”. J. Geotech. Eng. Div., ASCE, 101:1037-1053.
- Vermeer, P.A. (1978). “A Double Hardening Model for Sands”. Géotechnique, 28: 413-433.
- Nova, R and Wood, D.M. (1979). “A Constitutive Model for Sand in Triaxial Compression”. Int. J. Numer. Anal. Meth. Geomech., 3:255-278.
- Dafalias, Y.F. and Herrmann, L.R. (1982). “Bounding Surface Formulation of Soil Plasticity”. Chapter 10 in Soil Mechanics-Transient and Cyclic Loads, Pande, G.N.and Zienkiewicz, O.C., eds., pp. 253-282, John Wiley and Sons Ltd.
- Prevost, J.H. (1985). "A Simple Plasticity Theory for Frictional Cohesionless Soils”.Soil Dynamics and Earthquake Eng., 4:9-17.
- Pastor, M., O.C. Zienkiewicz, and A.C. Chan. (1990). “Generalized Plasticity and the Modelling of Soil Behavior”. Int. J. Numer. Anal. Methods Geomech., 14:151-190.

PAPERS FOR ADVANCED READING CO-AUTHORED BY Y.F. DAFALIAS

The following five papers co-authored by Y.F. Dafalias and his ex-students are recommended for advanced level soil plasticity reading. A very brief and very simple sixth paper on clay anisotropy is added at the end of the list, as a natural extension of the previous classical paper #3 on isotropic clays.

- Anandarajah, A. and Dafalias, Y.F. (1986). "Bounding Surface Plasticity. III: Application to Anisotropic Cohesive Soils". Journal of Engineering Mechanics, ASCE,112:1292-1318.
- Kaliakin, V.N. and Dafalias, Y.F. (1990). "Theoretical Aspects of the Elastoplastic-Viscoplastic Bounding Surface Model for Cohesive Soils". Soils and Foundations, 30:11?24.
- Wang, Z.L., Dafalias, Y.F., and Shen, C.K. (1990). "Bounding Surface Hypoplasticity Model for Sand". Journal of Engineering Mechanics, ASCE, 116:983-1001.
- Manzari, M.T. and Dafalias, Y.F. (1997). "A Critical State Two-Surface Plasticity Model for Sands". Geotechnique, 47:255-272.
- Li, X.S., and Dafalias, Y.F.(2002). “Constitutive Modeling of Inherently Anisotropic Sand Behavior”. Journal of Geotechnical and Geoenvironmental Engineering, ASCE, 128: 868-880.
- Dafalias, Y.F. (1986). “An Anisotropic Critical State Soil Plasticity Model”. Mechanics Research Communications, 13:341-347.

Top ten papers on the Pressuremeter

Suggested by Professor Jean-Louis Briaud, Professor and Holder of the Buchanan Chair, Department of Civil Engineering, Texas A&M University. List compiled in October 2004.

- Baguelin F., Jezequel J.-F., Shields D.H., 1978, "The Pressuremeter and Foundation Engineering", TransTech Publications, Clausthal-Zellerfeld, Germany.
- Mair R.J., Wood D.M., 1987, "Pressuremeter Testing: Methods and Interpretation", CIRIA, Butterworths, London, UK.
- Briaud J.-L., 1992, "The Pressuremeter", A.A. Balkema, Brookfield, VT, USA.
- Wroth C.P., Hughes J., 1973, "An Instrument for the In Situ Measurement of the Properites of Soft Clays, Int. Conf. Soil Mechanics and Foundation Engineering, Moscow.
- Menard L., 1975, "The Menard Pressuremeter: Interpretation and Application of the Prsssuremeter Test Results to Foundations Design", Sols-Soils, No. 26, Paris, France.
- Aubeny, C.P., Whittle, A.J., and Ladd, C.C. “Effects of disturbance on undrained strengths interpreted from pressuremeter tests,” ASCE J. Geotech. and Geoenv. Engrg., Vol. 126, No. 12, pp. 1133-1144, 2000.
- Briaud J.L., “SALLOP: Simple Approach for Lateral Loads on Piles,” Journal of Geotechnical and Geoenvironmental Engineering, Vol. 123, No. 10, pp. 958-964, ASCE, New York, October 1997.
- Briaud J.L., Jeanjean P., 1994, “Load Settlement Curve method for Footings on Sand,” Proceedings of the ASCE Specialty Conference “Settlement 94” at Texas A&M University, 40, USA.
- Baguelin F., Bustamante M., Frank R.A., 1986, "The Pressuremeter and Foundations: French Experience", Use of In Situ Tests in Geotechnical Engineering, ASCE Geotechnical Special Publication no. 6, ASCE, Reston, Virginia, USA.
- Hughes J.M.O., Wroth G.P., Windle D., 1977, "Pressuremeter Tests in Sand", Geotechnique, Vol.27, No.4, Institution of Civil Engineers, London, UK.

Top ten papers on Embankment Dams

Suggested by David Rees Gillette, P.E., PhD, Bureau of Reclamation, Denver CO. List originally compiled: June 2005. Revision #: 2: Latest revision: May 2011.

List originally compiled: June 2005 Latest update: May 2011

- Casagrande, A. (1961), “Control of Seepage through Foundations and Abutment of Dam,” First Rankine Lecture, Geotechnique vol.11, no. 3, pp 159-182. Is there anything more important than foundation preparation?
- Houlsby, A.C. (1977), "Engineering of Grout Curtains to Standards," Journal of the Geotechnical Division, Proceedings of the American Society of Civil Engineers, Vol. 103, No. GT9, pp. 953-970. One of relatively few good references I've seen on the practice of foundation grouting.
- Milligan, Victor, "Some Uncertainties in Dam Engineering," 38th Karl Terzaghi Lecture, Journal of Geotechnical and Geoenvironmental Engineering, vol. 129, no. 9, pp.785-797. Excellent practical lessons from case histories.
- Peck, R.B. (1988), "The Place of Stability Analysis in Evaluating the Safety of Existing Embankment Dams," Civil Engineering Practice, Fall 1988, pp. 67-80. Everybody does stability analysis. But what does it mean?
- Seed, H.B., F.I. Makdisi, and P. de Alba (1978), "Performance of Earth Dams During Earthquakes," Journal of the Geotechnical Division, Proceedings of the American Society of Civil Engineers, Vol. 104, No. GT7, pp. 967-994. Review and analysis of case histories.

- Sherard, J.L. (1987), "Lessons from the Teton Dam Failure," Engineering Geology, vol. 24, pp. 239-256 and discussions that follow. Probably the single most important case history of a dam failure for us to learn about foundation treatment, site selection, and dam-safety "culture."
- Sherard, J.L. and J.B. Cooke (1987), "Concrete Face Rockfill Dam: I. Assessment," ASCE Journal of Geotechnical Engineering, Vol. 113, No.10, pp. 1096-1112, and Cooke, J.B. and J.L. Sherard (1987), "Concrete-Face Rockfill Dam: II. Design," ASCE Journal of Geotechnical Engineering, Vol. 113, No.10, pp. 1113-1132.
- Sherard, J.L. and L.P. Dunnigan, (1989), "Critical Filters for Impervious Soils," ASCE Journal of Geotechnical Engineering, Vol. 115, No. 7, pp. 927-947. The basis for most modern filter criteria.
- Terzaghi, Charles, (1929), "The Effects of Minor Geologic Details on the Safety of Dams," Transactions, American Institute of Mining and Metallurgical Engineers, 215, pp. 31-44. Also known as Terzaghi, Karl.
- Terzaghi, K. and Y. LaCroix (1964), "Mission Dam: An earth and rockfill dam on a highly compressible foundation," Geotechnique, vol. 14, no. 1, pp. 14-50. Fascinating case history of a dam constructed under very difficult conditions on a very difficult foundation.

Some others of note:

- Duncan, J.M., S. Wright, and K.S. Wong (1988), "Slope Stability During Rapid Drawdown", H.B. Seed Memorial Volume, pp. 253-272.
- Lowe, J. III (1982), "Contributions of the Tarbela Dam Project to Hydro-Project Design," Second Annual USCOLD Lecture, Atlanta, Georgia.
- Marcuson, W.F. III, P.F. Hadala, and R.H. Ledbetter (1996), "Seismic Rehabilitation of Earth Dams,", ASCE Journal of Geotechnical Engineering, Vol. 122, No. 1, pp. 7-20.
- Middlebrooks, T.A. (1952), "Progress in Earth-Dam Design and Construction in the United States," Civil Engineering, September 1952.

Top ten papers on Active Faulting

Suggested by Robert H. Sydnor, Engineering Geologist, Seismologist, Hydrogeologist. List compiled: July 2005.

- Bonilla, Manuel G., and Lienkaemper, James J., 1991, Factors affecting the recognition of faults exposed in exploratory trenches: U.S. Geological Survey Bulletin 1947, 54 p.
- Burbank, Douglas W., and Anderson, Robert S., 2001, Tectonic geomorphology: Blackwell Science, 274 p.
- Noller, J.S., Sowers, J.M., and Lettis, W.R., editors, Quaternary Geochronology: American Geophysical Union, Reference Shelf vol. 4, 581 p. (comprehensive treatise).
- Hart, Earl W., and Bryant, William A., 1997, Fault–rupture hazard zones in California: California Geological Survey, Special Publication 42, 1997 edition with 1999 supplements, 38 p. download pdf from: www.conservation.ca.gov/cgs.
- Keller, Edward A., and Pinter, Nicholas, 2002, Active tectonics, 2nd edition: Prentice–Hall, 9 chapters, 362 p.
- McCalpin, James P., editor, 1996, Paleoseismology: Academic Press, 9 chapters, 588 p.
- Scholz, Christopher H., 2002, The mechanics of earthquakes and faulting, 2nd edition: Cambridge University Press, 7 chapters, 471 p.
- Shlemon, Roy J., 1985, Application of soil–stratigraphic techniques to engineering geology: Bulletin of the Association of Engineering Geologists, vol. 22, no. 2, p. 129–142.
- Sieh, Kerry E., 1996, The repetition of large–earthquake processes: Proceedings of the National Academy of Sciences, vol. 93, p. 3764–3771. pdf at: www.pnas.org
- Yeats, Robert S., Sieh, Kerry E., and Allen, Clarence R., 1997, The geology of earthquakes: Oxford University Press, 568 p. (especially Chapter 6, Quaternary Timescales and Dating Techniques; and Chapter 7, Tectonic Geomorphology).

(από geoengineer, http://www.geoengineer.org/publications/top-ten-papers)

ΚΑΙ …
TOP 10 REFERENCES IN GEOTECHNICAL ENGINEERING

Top 10 References in Geotechnical Engineering

It will be very tough for anyone to list the top 10 textbook or references in Geotechnical Engineering. In this list, I assume that you have graduate degree in Geotechnical Engineering.

1. Undeniably: ***Terzaghi*, K., *Peck*, R. B., and *Mesri*, G.** (1996). Soil Mechanics in Engineering Practice, 3rd Edition, Wiley

2. ***Lambe and Whiteman*** - 1981 - Soil Mechanics

3. ***Bowles*** - It is considered one of the most reference material after above three books. It is a great reference book for practicing engineers.

4. - to be added later -

   I am still not decided whether ***Tomlinson***'s textbook on pile foundation should be placed on #4 or ***Poulos and Davis***'s Pile Foundation Analysis and Design should be placed on #4. I do not want to put both on top 10. Poulos' book gives us deep theoretical knowledge, and Tomlinson's textbook aligns more on practical aspect. Lets wait sometime. When I think of Poulos' Pile Foundation, then I also remember their book on Solutions to Elastic Foundations [I have to find exact title, later], a wonderful book before we have sophisticated computer in our reach. Listen to readers which one will they prefer. I have both books in my book selves for more than 25 years. I love both of them. I don't want to put #4A and #4B. It will be hard choice at the end of day because we will have to select one: 51/49. No offense to each of the authors.

5. ***B. M. Das*** - any edition is OK - You need to be very careful when you use equations in this book. Some equations are typed incorrectly. Cross check them with another textbook (#4 or #6 below, or another textbook, e.g. by Budu) It is a great reference book with great worked out example problems. It is great reference book for those who are heading PE Exam. The book comes in reshuffled form as a new look, and in the rush, the author does not correct the same errors they had from the beginning. BM Das also has a lab testing manual in Geotechnical Engineering. It is worth having as a combo.

6. ***NAVFAC*** - Soil Mechanics - DESIGN MANUAL 7.01 REVALIDATED BY CHANGE 1 SEPTEMBER 1986 and other complementary volumes.

   NAVFAC DM 7.02 or DM 7.2, 1 September 1986

   This document is back in new version [not sure how much it has changed from the previous original edition]; Find it online: Use Google Search.

   Considered by many to be the best reference series on soil mechanics and foundations, although somewhat dated now. Published by the Naval Facilities Engineering Command (NAVFAC) in Norfolk, Virginia.

7. ***IBC - Chapter 18 plus 16***. - I would suggest every Geotech Engineer or teachers or researchers keep it. I would also suggest you to keep a copy of NYC version of this chapter [Even if you are practicing outside the jurisdiction of NYC] : soil classification section is my favorite part of NYC Version of IBC Chapter 18.

8. ***Smith and Griffiths*** (19XX) - Programming the Finite Element Method.

9. Geotechnical Engineering Investigation Handbook, Second Edition Book by ***Roy E Hunt***

10. - to be added later - I want to keep it for reader's suggestion.

Additional Textbooks that I would proudly recommend in the Top 100 references list:

11. Smith's Elements of Soil Mechanics, 9th Edition, ***Ian Smith***, ISBN: 978-0-470-67339-3, 488 pages, September 2014, Wiley-Blackwell. I believe its early version was a very small, concise, precise, and thinnest textbook in soil mechanics. I always loved this tiny textbook in soil mechanics. It was my first textbook in soil mechanics (in my bookshelf) published by International Publisher. Interestingly, on page 262 in this newest edition (9th ed.), one of my paper was mentioned. I am honored to have my name appear in this textbook. Having your name in elementary textbook is more valuable than appearing it in an advanced level reference book. Thanks to Prof. Smith.

12. A Short Course in Foundation Engineering By ***N. E. Simons, Bruce Keith Menzies***, Published by Telford, ICE.

13. ***Craig***'s Soil Mechanics, Eighth Edition - CRC Press Book https://www.crcpress.com/Craigs-Soil-Mechanics...Craig /p/.../97804155612 CRC Press: "From the foundations of the subject through to its application in practice, Craig's Soil Mechanics provides an indispensable companion to undergraduate..."

    I have Seventh Edition of this textbook. If you are in US, this textbook is not as common as BMDas's or McCarthy (Book #14 as mentioned below), primarily, because we are still addicted [obsessed??] to FPS system. Remember FPS system is no more called British System in US, because British have abandoned it in 1980s, since then it has been renamed in US as US Customary Units or [Other Commonly used names: American System of Measurement, ...]. If you use Metric /SI system in a meeting room, it will turn like Situation Room in Whitehouse on a surprising breaking news on CNN: panicking the entire room, and trying to find a guy who can confidently convert the number into US Customary Unit. Therefore, any textbook exclusively in SI Units are not a part of handy reference book in US. No offense. Its truth. Lets face it. Great with BM Das's books are that the publisher has at least one edition in SI Unit and that is the reason this book is on top list either sides of Atlantic and pacific ocean. Bowles Textbook also had a low cost edition in SI Unit and that was the book I purchased as a part of my undergraduate studies.

14. Essentials of Soil Mechanics and Foundations: Basic Geotechnics Book by ***David F. McCarthy***.

15/16/17: "Soil Behaviour and Critical State Soil Mechanics", TextBook by ***David Muir Wood*** and "The Mechanics of Soils - An introduction to critical state soil mechanics" -***J. H. Atkinson and P. L. Bransby*** are two very important books on Critical State Soil Mechanics. There is another first book on Critical State Soil Mechanics which is available probably only in some east Asian countries because these books are very popular in these countries and printed in affordable price. Atkinson and Bransby is no more available in a regular bookstore. In 199x, Atkinson wrote a separate book on Soil Mechanics with intro to Critical State Soil Mechanics. I am wondering why did not they write a second edition. Atkinson has given Rankine Lecture in 200x. I had an opportunity to listen to his recap of Rankine lecture presented in Japanese Geotech Society, Tokyo. When DM Wood came to Japan for a short visit, signed on his book that I had. Atkinson-Bransby was my textbook in my Grad school. I will list them in top 100, but not in Top 10.

18. Nonlinear Analysis in Soil Mechanics: Theory and Implementation (Developments in Geotechnical Engineering) by ***W.F. Chen and E. Mizuno***.

19. Reserved for another book.

20. Dr ***Howard Perko*** - "Helical Piles." This is a great textbook for systematic knowledge in Helical Pile from history to current state of Helical Piles. My most favorite page that I refer almost everyday is Page 101 on this book. It costs only $90+ in Amazon.com.

    Well, you should also know that if you want to buy a book on Helical Pile to design Helical Pile, then it will be better to contact Helical Pile Manufacturers for free design manuals. These manuals are really good and enough. Some Helical Pile manufacturers also provide design software for free to $250/user. Remember that such software may be free but cannot be freely distributed because they are smart enough to confine the software code to your one computer only. I love that kind of security. If I remember correctly, Dr. Dimitrios Konstantakos, CEO at Deep Excavation LLC, has recently announced through his LinkedIn Page that his company has also developed a software to design Helical Piles. You may directly contact him. Last year, around March, I had great opportunity to listen to his two Webinars.

Published on June 2, 2016 by **Gyaney Pokharel**, Sr. Geotechnical Engineer at MNW Engineering, Member of the ASCE Ground Improvement Technical Committee in **LinkedIn**.

ΠΡΟΣΦΟΡΑ ΕΡΓΑΣΙΑΣ

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Applications are invited for one PhD studentship to work on an Impact Studentship, to develop the next generation of dissipating devices to retrofit heritage buildings. The research work will be developed in close collaboration with CINTEC International, worldwide leader in retrofitting systems for heritage structures subjected to earthquake loading.

Studentship Description

The purpose of the research is to develop the next generation of masonry anchoring friction devices that will offer improved short-term performance as well as a reliable and robust long-term behaviour. Fundamental research into advanced materials to deliver a smooth dissipative action based on friction principles is needed, as well as further design to produce a device that can be easily installed in heritage and cultural structures with a minimum of disruption and intervention. Moreover the long term performance of the device in situ will be accurately studied to ensure it is functioning as intended when the need arises. This will deliver a whole lifecycle costed low-maintenance device, for which production, installation and maintenance costs would have been carefully considered. The proposed PhD programme will entail both experimental and computational activities. Previous collaborative work of the partners has led to shared patents.

Person Specification

The applicants should possess a good honours degree (1st Class or 2:1 minimum) at MEng or MSc level in Civil or Structural Engineering or earthquake Engineering. Candidates should have a robust basic knowledge of dynamics and/or earthquake engineering. Candidate should also demonstrate some experience of experimental work, practical on site engineering work, computational proficiency, proficiency of use of structural analysis packages. A keen interest in building heritage, knowledge of masonry structures and issues relating to structural conservation are important desirable attributes.

Eligibility

Applications are invited from UK and EU members, residing in UK.

Start Date

The post will be available from October 2016

Prof. Dina D'Ayala, Dr. Ing., PhD
Professor of Structural Engineering
Head of Structures
CEGE - UCL
Chadwick Building
London WC1E 6BT

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DB Engineering & Consulting GmbH

From: van Houten, Vincent [mailto:Vincent.van-Houten@deutschebahn.com]

Dear Friends and Colleagues,

I hope you are all well!

We might have some upcoming projects in our region in the next months for which we will require a wide variety of experienced international experts who are willing and able to work for us in Eastern Europe.

Such experts include:

- The three detailed profiles below (for the tunneling positions also experience with street tunnels is o.k.)
- Further railway supervision Experts with specializations including but not limited to Trackwork, Signaling (+Telecom), Electrification, Civil Works etc.

It would be very much appreciated if you can help. As you are competent experts in the business you surely know many other experts with relevant experience who may just be looking for a next engagement.

Anyone interested may contact me directly.

Many thanks, best regards and greetings from Berlin,

Vincent van Houten

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ΠΡΟΣΕΧΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΚΔΗΛΩΣΕΙΣ

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

Conference in Honour of Michele Maugeri, 01 July 2016, Catania, Italy, www.associazionegeotecnica.it

4th GeoChina International Conference Sustainable Civil Infrastructures: Innovative Technologies for Severe Weathers and Climate Changes, July 25-27, 2016, Shandong, China, http://geochina2016.geoconf.org

S3: Slopes, Slides and Stabilization, August 1-3, 2016, Denver, USA, events@dfi.org

6th International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics August 1-6, 2016, Greater Noida (NCR), India, www.6icragee.com

EUROC 2016 - ISRM European Regional Symposium Rock Mechanics & Rock Engineering: From Past to the Future, 29-31 August 2016, Ürgüp-Nevşehir, Cappadocia, Turkey http://eurock2016.org

ICEGE 2016 1st International Conference on Energy Geotechnics, 29-31 August 2016, Kiel, Germany, www.iceg-2016.de

☙ ❧

International Symposium
Qualification of
Dynamic Analyses of Dams and their Equipments
and of
Probabilistic Assessment of Seismic Hazard in Europe
31 August - 2 September 2016, Saint-Malo, France
www.barrages-cfbr.eu/2016-Barrages-et-seismes.html

This international symposium is the first annual meeting of the ICOLD European Club Working Group *"Dams and Earthquakes"*.

A lot of seismic methods are available and a lot of analyses are required by new stringent regulations in Europe.

The points are : "How to define the seismic hazard? How the seismic hazard assessment and dynamic analyses are validated? What are the evidences of flaws or accuracy that you have experimented?"

CFBR invites JCOLD experts to present and discuss qualification of seismic analyses.

The deliverables of the symposium will be fundamental packages of qualification of seismic analyses : case studies of validation with measured data (including accelerograms at foundation and crest) compared to predicted results of seismic analyses.

Session 1	Qualification of probabilistic seismic hazard assessment
Session 2	Performance of CFRD & AFRD
Session 3	Soils properties and simplified analysis
Session 4	Qualification of seismic analysis of embankment dams
Session 5	Qualification of seismic analyses of concrete dams
Session 6	Discussion on qualification of seismic analyses of dams
Session 7	Qualification of equipment
Session 8	Conclusions of the 1st ICOLD European Club Working Group

Dr. Jean-Jacques FRY
Chairman EWG "Dams and Earthquakes"
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Travel Instructions

http://www.pgl-congres.com/informations-pratiques/acces/

☙ ❧

3rd ICTG – 3rd International Conference on Transportation Geotechnics 4 - 7 September 2016, Guimaraes, Portugal, www.civil.uminho.pt/3rd-ICTG2016

IAS'5 5th International Conference on Geotechnical and Geophysical Site Characterisation, 5-9 September 2016, Gold Coast, Queensland, Australia, http://www.isc5.com.au

☙ ❧

September 6-9, 2016, Singapore
www.equip-global.com/urban-underground-space-and-tunnelling-asia-summit-2016

Asia's Leading Urban Underground Space & Tunneling Summit will return to discuss leading practices, innovative techniques and sustainable solutions for Design, Engineering & Construction of Underground Space and Tunneling Projects!

Tunnelling and Underground infrastructure has become a world-wide trend solution to space scarcity, increase world population and urbanization. Particularly in Asia, underground infrastructure and tunnelling construction is fast becoming a priority in a rapidly-urbanizing Asia.

Urban Underground Space & Tunnelling Asia Summit 2016 will provide excellent insight into the complexity and challenges of tunnelling in urban areas, mitigating construction risk, tunnelling through difficult ground conditions and managing groundwater inflows as well as issues relevant to the design and construction of underground works. This will be discussed through a series of case study presentations, underground space/tunnelling project updates and expert panel discussions and workshop sessions.

For more info on Urban Underground Space & Tunnelling Training Workshops, please email us at enquiry@equip-global.com.

The World Multidisciplinary Earth Sciences Symposium– WMESS 2016, 5-9 September 2016, Prague, Czech Republic www.mess-earth.org

3rd European Conference on Unsaturated Soils E-UNSAT 2016, 12-14 September 2016, Paris, France, http://eunsat2016.sciencesconf.org

ACCUUS 2016 15th World Conference Underground Urbanisation as a Prerequisite for Sustainable Development, September 12-15, 2016, http://acuus2016.com

SAHC 2016 - 10th international Conference on Structural Analysis of Historical Constructions 13-15 September 2016, Leuven, Belgium, www.sahc2016.be

Hydropower Development Europe 2016 - Flexible hydropower and pump storage generation for a safe renewable electricity system, 14 – 15 September 2016, Lyon, France, http://www.wplgroup.com/aci/event/hydropower-development-europe-2016

13 Baltic States Geotechnical Conference Historical Experiences and Challenges of Geotechnical Problems in Baltic Sea Region, 15 - 17 September 2016, Vilnius, Lithuania, http://www.13bsgc.lt

Dam Surveillance Practice - 3rd Experts Seminar, 18 - 23 Sep 2016, Landeck, Tyrol, Austria, www.atcold.at/de/home-1/41-2016-veranstaltungen/155-dam-surveillance-practice-2016

ACE 2016 12th International Congress on Advances in Civil Engineering, 21-23 September 2016, Istanbul, Turkey, http://www.ace2016.org

International Geotechnical Engineering Conference on Sustainability in Geotechnical Engineering - Practices and Related Urban Issues, 23-24 September 2016, Powai, Mumbai, India, www.igsmumbaichapter.in

EuroGeo 6 – European Regional Conference on Geosynthetics, 25 – 29 Sep 2016, Istanbul, Turkey, www.eurogeo6.org

8th Nordic Grouting Symposium State of the art – Future Development, 26-27 September 2016, Oslo, Norway, http://nordicgrouting.com

5th International Scientific Conference on Industrial and Hazardous Waste Management, 27 - 30 September 2016, Chania, Crete, Greece, http://hwm-conferences.tuc.gr

Basements and Underground Structures 2016, 5-6 October 2016, London, United Kingdom, https://basements.geplus.co.uk

2nd International Specialized Conference on Soft Rocks – ISRM 2016 Understanding and interpreting the engineering behavior of Soft Rocks, 6-7 October 2016, Cartagena, Colombia, www.scg.org.co/?p=1634

Achievements, opportunities and challenges
10-12 October 2016, Montreux, Switzerland
www.hydropower-dams.com/hydro-2016.php?c_id=88

The annual conferences in this series are the most international gatherings for the hydropower profession, bringing together experts in the various inter-related disciplines in the field of hydropower development. Emphasis is on encouraging the advancement of carefully planned hydroschemes in the less developed countries, and equally, maximizing the benefits of existing hydro installations, by maintenance and timely upgrading.

Three main tracks of sessions cover technical, economic/financial and environmental issues, with much emphasis on emerging topics, such as climate resilience, cyber security and capacity building/succession planning.

The events also provide a bridge between policy-makers and practitioners, highlighting topical issues and encouraging balanced debate.

Past events have taken place in Budapest (1994); Barcelona (1995); Lausanne (1996); Portorož (1997); Aix en Provence (1998); Gmunden (1999); Bern (2000); Rivadel Garda (2001); Kiris (2002); Dubrovnik (2003); Porto (2004); Villach (2005); Porto Carras (2006); Granada (2007); Ljubljana (2008); Lyon (2009); Lisbon (2010); Prague (2011); Bilbao (2012); Innsbruck (2013); Cernobbio (2014); and Bordeaux (2015).

Today the conferences attract around 1500-1600 participants, representing more than 80 countries. The main water -and energy- related professional associations, such as ICOLD and the International Energy Agency, play a major role in sessions and often host side events.

CONFERENCE SESSIONS

Session 1 – Global hydropower development opportunities

Session 2 – Finance and investment

Session 3 – Climate issues
Session 4 – Hydraulic machinery
Session 5 – Swiss hydropower expertise
Session 6 – Risk management and insurance
Session 7 – Flood protection and hydrology
Session 8 – Hydraulic machinery
Session 9 – Contractual aspects
Session 10 – Gates and spillways
Session 11 – Hydropower development in Africa
Session 12 – Civil works: Design and construction
Session 13a – On-going pumped-storage projects in Europe
Session 13b – On-going pumped-storage projects worldwide
Session 13c – New ideas in pumped-storage development
Session 13d – Improvements in pumped-storage equipment technologies
Session 14 – Social aspects
Session 15 – Civil works: materials
Session 16 – Hydropower and fish (IEA session)
Session 17 – Decision making for hydro plant renewals (IEA session)
Session 18 – Dam safety and monitoring
Session 19 – Environment: Fish protection
Session 20 – Capacity building and training
Session 21 – Hazard and risk
Session 22 – Environment
Session 23 – Operation and maintenance
Session 24 – Powerplant safety
Session 25 – Small and low head hydro Innovative design and development
Session 26 – Sedimentation management
Session 27 – Refurbishment and upgrading
Session 28 – Small and low head hydro
Session 29 – Tunnels and underground works
Session 30 – Grid issues
Session 31 – Marine energy potential and development
Session 32 – Electrical engineering

Pre-conference Small Hydro Workshop:

Design a small hydropower project in one day

CONTACT DETAILS

For enquiries concerning registration and accommodation, contact:

ASK Event Management Abigail Stevens, Co-Director
Tel. +44(0)7931613482
Email abigail@askeventmanagement.com
On-line registration via: www.hydropower-dams.com
For further details of the programme, please contact:
Mrs Margaret Bourke at: Hydropower & Dams,
PO Box285, Wallington,
Surrey SM66AN, UK.
Tel: + 44(0)2087737244
Fax: + 44(0)2087737255
Email: hydro2016@hydropower-dams.com
Website: www.hydropower-dams.com

The British Tunnelling Society Conference and Exhibition 2016, October 11 – 12, 2016, London, United Kingdom www.btsconference.com

October 13 - 14th, 2016, Salzburg, Austria
www.oegg.at/en/geomechanics-colloquium-3/65th-geomechanics-colloquium-2016-georg-feder-colloquium-79

The Austrian Society for Geomechanics cordially invites you to the **65th Geomechanics Colloquium** which is held in Salzburg at the congress center "Salzburg Congress" on **October 13th and 14th, 2016**.

The **Session Topics** are:

- Geothermal energy - experiences, chances and risks
- TBM - expectations and reality
- Geomechanical aspects in mining (surface and underground mining)
- Large projects in Austria

(agenda at https://www.oegg.at/upload/Download/GMK2016/GMK2016_Hauptprogramm_EN_web.pdf)

Prior to the Colloquium, the **10th Austrian Tunnel Day** is scheduled on **October 12th, 2016.** The **Topics** are:

- Special challenges at current large construction sites
- BIM in tunnelling
- Contractual project specifications in tunnelling - What are the misconceptions?
- Innovation award

(agenda at https://www.oegg.at/upload/Download/GMK2016/TT2016_Hauptprogramm_DE_web.pdf)

ARMS 9, 9th Asian Rock Mechanics Symposium, ISRM Regional Symposium, 18-20 October 2016, Bali, Indonesia, http://arms9.com

SFGE 2016 Shaping the Future of Geotechnical Education International Conference on Geo-Engineering Education 20 - 22 October 2016, Minascentro, Belo Horizonte, MG, Brazil, http://cobramseg2016.com.br/index.php/sfge-sobre/?lang=en

10th ICOLD European Club Symposium & Exhibition, 25-30 October 2016, Antalya, Turkey, http://trcold.com

1st International Symposium on Seismic Rehabilitation of Heritage Structures 30-31 October 2016, Tehran, Iran, www.srhs.ir

NEMO International Conference Probing the Santorini volcano for 150 years / Διεθνές συνέδριο NEMO 150 χρόνια μελέτης ηφαιστείου της Σαντορίνης, 3-5 November 2016, Santorini, Greece, http://nemo.conferences.gr

GeoAsia 6 - 6th Asian Regional Conference on Geosynthetics 8-11 November 2016, New Delhi, India, http://seags.ait.asia/news-announcements/11704

13 - 15 November 2016, Dubai, United Arab Emirates
www.undergrounduae.com

Dear Colleague,

Building on the strong foundations of the Underground Infrastructure and Deep Foundations series, we are pleased to announce its return to the UAE for November 2016!

As you know there are many underground infrastructure projects in the pipeline for the UAE. From previous years we have identified many challenges when developing underground infrastructure. This year we have highlighted that the main challenges for the UAE are; constructing underground infrastructure in urban environments, foundations of high-rise buildings, rising water tables and mitigating geotechnical risk.

With a global, first-class speaker line-up of geotechnical and structural experts who share a wealth of academic and practical experience, the 3rd Annual Underground Infrastructure & Deep Foundations Summit UAE will be an unmissable opportunity to join leaders in the field as they tackle these major issues.

So what can you expect from the 2016 event?

- Industry expert Professor John Endicott, discusses exciting and practical possibilities of underground cities in the UAE with case study examples of Scandinavia, Helsinki, Montreal and Singapore
- HDR discusses how to effectively manage and control groundwater in urban environments to prevent project delays and increased costs
- Atkins debate the advantages and disadvantages of pile groups and pile rafts for the foundations of high-rise buildings and which is the best for your project
- CH2M, BESIX demonstrate how to prevent geotechnical hazards when constructing in reclaimed land, karst environments and sabkha soil
- Arup, NSCC, CH2M, AECOM, Municipality of Abu Dhabi and WSP discuss how to ensure project value through geotechnical investigations

With huge opportunities for infrastructure projects across the UAE, this conference is the ideal place for existing players and new market entrants to access critical project intelligence.

I look forward to seeing you in Dubai this November.

For more information or to register:

tel: +971 4 364 2975
email: enquiry@iqpc.ae
follow @iqpcmena
www.undergrounduae.com

November 14-16, 2016, Florida University, USA
http://undergroundriskmanagement.com/agenda

The cost to build underground construction projects can reach into the billions of dollars, and the trend toward larger and larger projects in more challenging geologic environments continues worldwide. However, the cost can be even higher if careful risk management practices are not adopted and implemented in the project planning, design and construction phases.

Risk Management in Underground Construction will bring together leading stakeholders involved in large scale underground construction projects. This new, three-day event will explore all aspects of risk management, with presentations and panel discussions featuring international experts in this field.

Topics Include:

- Hazard Identification and Risk Assessment
- Project Planning
- Project Design
- Contract Procurement
- Project Construction
- Contract Drafting
- Insurance Coverage
- Developing a Risk Identification Program
- Identifying Risk Factors
- Case Studies
- Litigation and Dispute Resolution
- Surety Bonding
- Analyzing Risks on Projects in Developing Countries
- Owner, Designer, Contractor and Insurer Responsibilities in Risk Management

Contact Us

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5th International Conference on Geotechnical Engineering and Soil Mechanics, 15-17 November 2016, Tehran, Iran, www.icgesm2016.ir

RARE 2016 Recent Advances in Rock Engineering 16-18 November 2016, Bangalore, India, www.rare2016.in

TBM DiGs Istanbul 2016 2nd International conference on "TBM DiGs in difficult grounds", 16-18 November 2016, Istanbul, Turkey, www.tbmdigsturkey.org

GEOTEC HANOI 2016, The 3rd International Conference on Geotechnics for Sustainable Infrastructure Development, 24-25 November, Hanoi, Vietnam, www.geotechn.vn

5th International Conference on Forensic Geotechnical Engineering, 8-10 December 2016, Bangalore, Karnataka, India, http://5icfge.com

International Symposium on Submerged Floating Tunnels and Underwater Tunnel Structures (SUFTUS-2016), 16—18 December 2016, Chongqing, China, www.cmct.cn/suftus

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 Geotechncial Engineering, 23 January 2017, Lahore, Pakistan, www.pges-pak.org/home/icncge-2017

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

TechnoHeritage
Red de Ciencia y Tecnología para la Conservación del Patrimonio Cultural

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

I am pleased to invite you to take part in **TechnoHeritage 2017** (*3rd International Congress on Science and Technology for the Conservation of Cultural Heritage*) to be held in **Cadiz, Spain during 20-23 May, 2017**. The Congress is organized by the Spanish Network of Science and Technology for the Conservation of Cultural Heritage (TechnoHeritage).

TechnoHeritage 2017 offers you:

- An interdisciplinary and international forum for discussions on all aspects of Cultural Heritage
- A special session focused on H2020 opportunities for Cultural Heritage topics
- A high-quality scientific programme including new emerging topics in Cultural Heritage such as: nanotechnology, underwater conservation and innovative monitoring techniques
- Publication of papers in indexed proceedings. In addition, a number of selected papers will be published in a high-quality journal with a high impact factor
- Reduced registration fee for students. In the case of undergraduate students, recognition of an academic ECTS credit
- An extraordinary venue for the conference. Cadiz, one of the oldest cities in Western Europe which preserves an important historical legacy, together with excellent beaches.
- A fantastic social programme including a tour of a Sherry Bodega, a Gala Dinner with flamenco show and a guided tour of Cadiz
- The reduced registration fee includes lunches, the Gala Dinner, and two different tours.

Congress Main Topics

The objective of the **TechnoHeritage 2017** Congress, organized by the Spanish Network of Science and Technology for the Conservation of Cultural Heritage, is to promote an interdisciplinary forum to discuss all aspects of Cultural Heritage conservation, according to the following specific aims:

- To stimulate cooperation and integration between otherwise heterogeneous fields (professionals and researchers from scientific, conservation-restoration and architecture areas)
- To promote networking among European research teams facing Horizon 2020
- To provide a comprehensive, up-to-date and state of the art picture on the following topics

T1. Deterioration of Cultural Heritage

- Environmental Assessment and Monitoring (Pollution, Climate Change, Natural Events)
- Agents and Mechanisms of Decay (Physical, Chemical and Biological)

T2. Nanomaterials and other Products for Conservation

- Cleaning products, Consolidants, Hydrophobic and Super hydrophobic products, Self-cleaning and Anti-graffiti agents, Biocides and Depollutant products

T3. New Technologies for Analysis, GPR applications, Protection and Conservation

- Non-Invasive Technologies, Security Technologies, Remote Sensing and G.I.S, UAV systems (i.e. drones) and 3D Laser scanning

T4. Underwater Cultural Heritage

- Protection and Conservation of archaeological sites, buildings and wrecks
- Evaluation of Underwater Decay

T5. 20th Century Cultural Heritage

- Conservation of Concretes, Contemporary Art and other modern Materials
- Preservation of Industrial Heritage

T6. Significance of Cultural Heritage

- Policies for Conservation
- Social Value

Contact: 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

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

The RETC, Rapid Excavation and Tunneling Conference, is a premier international forum for the exchange and dissemination of developments and advances in underground construction. The every two-year series of this conference provides a platform to discuss innovative solutions to the various challenges associated with the tunneling and underground space engineering and construction industry.

Conference attendance regularly exceeds 1,400 professionals from more than 30 countries. Industry sectors covered in the programme of technical presentations include: geotechnical engineering, site investigation exploration, environmental protection concerns, project economics, equipment manufacturing, government policy towards underground infrastructure development, water/wastewater systems and underground transportation needs. The conference includes a comprehensive exhibition, short courses, field trips and tours.

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

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

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

GeoAfrica 2017
3rd African Regional Conference on Geosynthetics
9 – 13 October 2017, Morocco

11th International Conference on Geosynthetics (11ICG)
16 - 20 Sep 2018, Seoul South Korea
csyoo@skku.edu

http://people-x.com/webmail/11ICG/m-e01.htm

AFTES International Congress
"The value is Underground"
13-16 November 2017, Paris, France

World Tunnel Congress 2018
20-26 April 2018, Dubai, United Arab Emirates

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

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E-mail: trushko@spmi.ru

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

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
csyoo@skku.edu

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

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Fax: (+65) 627 35754
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14th ISRM International Congress
2019, Foz de Iguaçu, Brazil

Contact Person: Prof. Sergio A. B. da Fontoura
E-mail: fontoura@puc-rio.b

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

Organizer: TC101

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.

ΕΝΔΙΑΦΕΡΟΝΤΑ ΓΕΩΤΕΧΝΙΚΑ ΝΕΑ

Geologists revisit giant Zion landslide

Zion Canyon cuts a 25km-long path through red Navajo Sandstone

US scientists have produced their most precise date yet for the landslide that shaped the iconic canyon running through what is now Zion National Park.

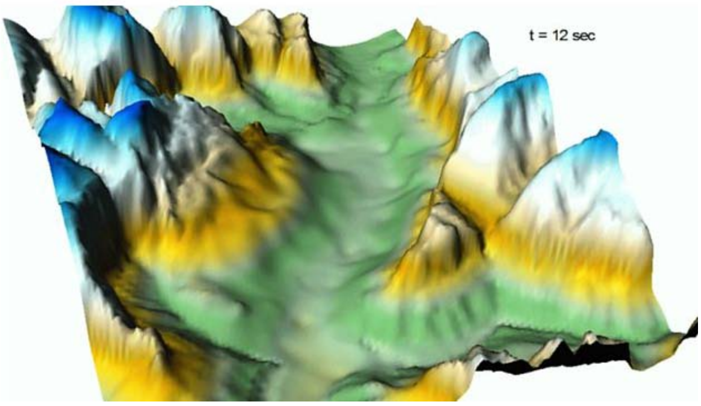
The colossal rock avalanche occurred about 4,800 years ago, they say, based on a study of some of its boulders.

The researchers have also re-examined the details of the event.

They find the slide probably contained some 286 million cubic metres of debris - enough to cover New York's Central Park to a depth of about 80m.

That volume dammed Zion Canyon's Virgin River, creating a lake that remained for centuries.

As sediments filled this lake, they gave the valley its distinctive flat floor, which today makes it very easy to cross on foot.



Watch a 5,000-year-old giant landslide unfold

The lake is gone; the relentless process of erosion eventually broke it, and the river is again cutting downwards.

And, as a consequence, roughly 45% of the original landslide deposits have been removed as well.

Jeff Moore, from the University of Utah, and colleagues report their investigations in the Geological Society of America's journal GSA Today.

The team was able to date the massive slip by examining the amount of beryllium-10 in several boulders.

Jeff Moore: "A spectacular landslide in a spectacular setting"

This radioisotope is produced when energetic space particles raining down from the sky hit the oxygen and silicon atoms in quartz minerals.

The longer a rock surface is exposed, the greater the build-up of beryllium-10.

Previous dating work, using less direct methods, put the age of the slide at somewhere between 3,900 and 7,900 years ago.

The Utah team's beryllium analysis strongly favours 4,800.

"Nine out of 12 of our samples gave an age that was very tightly consistent with this mean age of about 4,800 years," Dr Moore told BBC News.

The Sentinel: The slide initiated on the western flank of the canyon

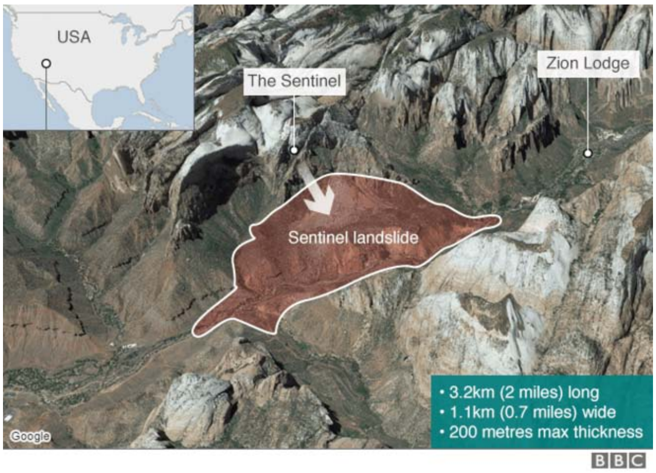
But just as interesting as the dating are the new estimates surrounding the dynamics of the slide.

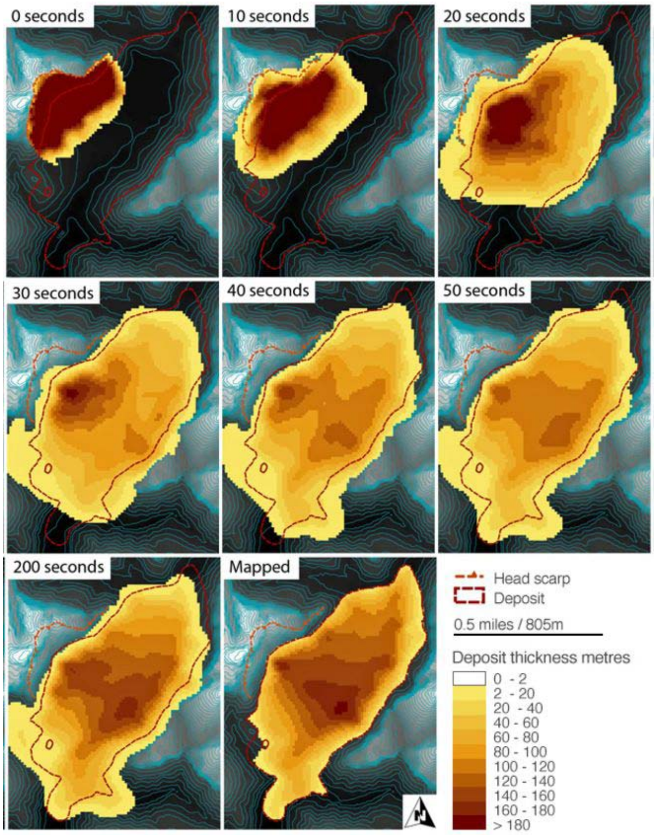
The event initiated in the cliff face of The Sentinel, a huge tower of rock on the western side of Zion Canyon.

The Utah team's simulations of how the flow progressed match the likely valley topography before the failure with the eventual distribution of deposits.

This gives the group confidence in their numbers - which are pretty stunning.

"It's a spectacular volume of material. You get, essentially, one of Zion's most massive cliffs collapsing, running across the canyon in 20 seconds with peak velocities of 90 metres per second (200mph)," said Dr Moore.





The slide event was all but over in 60-90 seconds, the simulations suggest

It is still not clear from the investigations what caused the rock avalanche. There is insufficient data on palaeo-earthquakes in the area to make a statement about a seismic trigger. It remains a possibility, but so too does a simple internal failure of the rock.

And while there is evidence for other rock avalanches in the canyon, Dr Moore says a repeat event is not something the National Parks Service nor tourists should be unduly worried about.

Just marvel at the spectacle, he urges.

"People when they go there, they look up to the huge Navajo sandstone cliffs, and I think it's a little more subtle to look down at our feet and wonder why this canyon is so accessible, why the valley floor is so flat?

"Studying landslides for my job, the story I tell is often connected to a lot of gloom and doom. But this is a case where a spectacular landslide did something in a spectacular setting, and it's an opportunity to reach out to people and tell them something new that they might not otherwise have known about landslides.

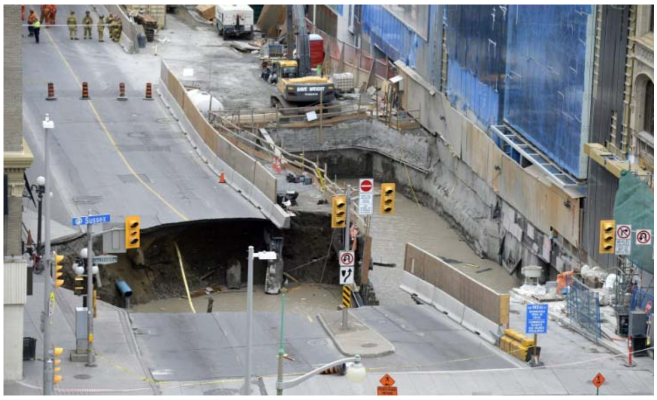
"I hope it is an enriching tale on the history of Zion."

Big tourist draw: The lake sediments left behind a flat valley floor

(Jonathan Amos / BBC Science Correspondent, 27 May 2016, http://www.bbc.com/news/science-environment-36392093)

Sinkhole spanning four-lane road swallows van in Ottawa

Sinkhole stretching sidewalk to sidewalk near Canada's parliament, and reports of gas leak, prompt evacuation of buildings



Water can be seen in a large sinkhole that formed in Ottawa on Wednesday. Photograph: Justin Tang/AP

A sinkhole spanning the width of a four-lane road has opened in downtown Ottawa, swallowing a van, causing a gas leak and forcing the evacuation of several buildings in the heart of Canada's capital.

The large sinkhole formed on Wednesday a few blocks away from parliament, in an area that was under construction and had been closed to all traffic save buses and taxis. There were no immediate reports of injuries.

Many on social media reported a "foul" smell of gas hanging over the area, prompting the hurried evacuation of a nearby shopping centre as well as a hotel and convention centre. Firefighters went door to door evacuating other businesses that sit along the busy stretch of road.

The gaping hole first appeared midmorning on Wednesday, with estimates putting it as large as five metres in diameter. Video taken from the scene showed dirty brown water gushing into a deep break in the paved road.

The sinkhole quickly grew to stretch from sidewalk to sidewalk of the four-lane road. As it widened, a parked dark van and a street lamp tumbled into the sinkhole.

The exact size of the sinkhole was being determined by engineers, who had been initially kept at bay by a ruptured water main and gas line, city officials said on Wednesday.

There was little indication of how long it would take to repair the damage, said Ottawa's mayor, Jim Watson. "It's a significant sinkhole in the downtown core. It has a major impact on our largest retail shopping centre, one of our major hotels as well as one of the busiest intersections and bus routes."

Speculation was rife that the cavernous hole in the pavement was linked to a 1½-mile (2.5km) underground tunnel being dug for the city's light rail transit system. Workers had been excavating in the area when the sinkhole began to form. All of them had made it out safely.

But Watson said it was too early to say whether the sinkhole was related to the underground drilling. "We can't confirm whether the tunnel had any impact on the sinkhole or whether it was a water main break or whether it was a leak of some type that destabilised the soil." City officials would, he hoped, be able to pinpoint the exact cause in the coming days.

In 2014, digging associated with the light rail transit system was linked to an eight-metre wide sinkhole that appeared just a few blocks over from the site of Wednesday's sinkhole.

(Ashifa Kassam / theguardian, Wednesday 8 June 2016, https://www.theguardian.com/world/2016/jun/08/sinkhole-ottawa-swallows-van)

Geosynthetic Design Software and Calculator Tools

It's no revelation that civil, environmental, and geotechnical engineering designs require a significant amount of calculation. The most advanced calculations, supported by due diligence and experience, can never be replaced by freeware and proprietary tools; but on the project selection and record-keeping side, a number of companies offer highly useful geosynthetic design software and calculator tools. Erosion and sediment control companies are doing the same. These aids can improve project efficiency and economics, as well as increase options for the user.

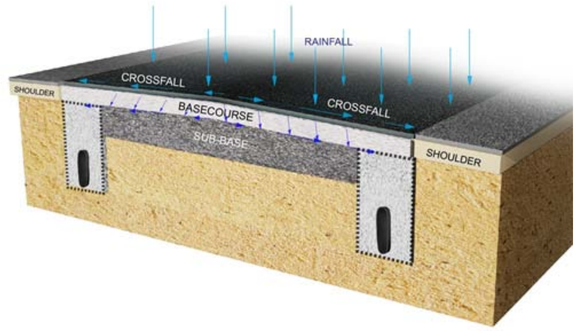
These tools can also help improve one's understanding of geosynthetics and affiliated material use.

What follows is a roundup of offerings from geosynthetics and erosion and sediment control companies, brief descriptions of the resources, and links to how you might acquire them.

This list is only a small amount of what's available. The editor of Geosynthetica welcomes your suggestions for future inclusions in this ongoing series. Contact Chris Kelsey, chris@geosynthetica.net.

DRAINAGE

Geofabrics Australasia has developed a web-based road design app focused on drainage performance and cost calculation. **Subsurface Drainage Design Software (SuDDS)** produces net cost and design comparative reports based upon user-entered project/design data. The program summarizes the notable calculations and can include CAD files of drainage profiles. SuDDS enables multiple projects to be created for any account, and within each project multiple design scenarios may be created. This gives the user ample flexibility for testing different approaches. SuDDS reports are exported into PDF, designs can be exported to CAD, and specs for relevant products can be exported to Word files for simple reuse in project documentation. Register to use this resource at **www.sudds.com.au**.



Subsurface Drainage Design Software (SuDDS) from Geofabrics Australasia

MacFLOW from Maccaferri targets drainage geocomposite design usage to replace granular drainage layers within vertical, flat, and sloped applications. This includes back-of-wall drainage, trench drainage or within the base, caps, and side-slopes of landfills. The product database includes the safety factors to be applied to fully take into consideration the uncertainties, including, for example, the long-term creep flow rate reduction due to the vertical load and the shear stress applied. Visit the **Design Software page on Maccaferri's website**, login, and access the resource.

EROSION CONTROL

ECDesigner™ is an engineer-designed, web-based calculator tool for rolled erosion product selection. The program, with slope and channel calculation sections, is supported by East Coast Erosion Control. ECDesigner™ quickly calculates site-specific conditions (e.g., gradients, project area, factor of safety) and delivers comprehensive outputs for design and submittals assistance. The program is rooted in RUSLE. East Coast Erosion Control reports that the software will update to RULSE 2 in the coming months.

Profile Products' PS^3 software delivers users into a sustainable, cost-effective erosion control and vegetation establishment system. PS^3 is rooted in the company's five fundamental approach: Soil Testing, Species Selection, Product

Selection, Installation, and Inspections & Maintenance. Uniquely, Profile opens the program with a free soil test. The resource integrates Hydraulically-applied Erosion Control Products (HECPs), Rolled Erosion Control Products (RECPs), Sediment Retention Fiber Rolls (SRFRs), and Prescriptive Agronomic Formulations (PAFs). PS[3]also allows for seamless soil testing and reporting of results. The software is free to use and has no limits on the number of projects that can be created. Full soil tests are included. The company's new Proganics calculator is also available to compare costs of topsoil, hauling, and importing. Register for free access at **www.ProfilePS3.com**.

Tensar North American Green offers **Erosion Control Materials Design Software (ECMDS)**. ECMDS, now in version 5.0, is a web-based program designed to ensure proper evaluation, design, and product selection of erosion control products for slope, channel, spillway, and similar applications. It's accessible on standard computers and tablets. Materials included in the program's evaluations include temporary erosion control blankets, hydraulic mulch, permanent turf reinforcement mats, scour protection, and hard armor (e.g., rock and gabions). The ECMDS also hosts the company's Cost Savings Estimator Tools, which are used for evaluating value-engineered solutions and related savings on material, labor, and installation costs. ECMDS is free with registration.

INSTALLATION & CQA

Glen and Joanna Toepfer of CQA Solutions Ltd. have cornered the market on digital tools for geosynthetics installation documentation and CQA vendor training. Their flagship tool, **SuperTek**, is a tablet-based program that through real-time data validation eliminates the redundant paper checks for seaming logs and destructs. The program enables roles and permissions-based access, instant data exports for certification reports, up-to-the-minute project punch lists, and remote project management. Based on 20+ years of field experience, the software has been found to provide technician time savings of 18% and an impressive 97% time saving on data preparation for certification.

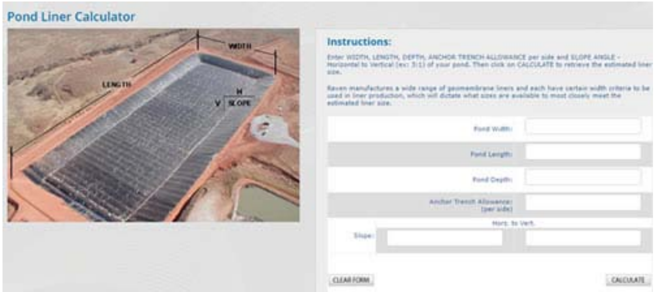
On the technology side, the SuperTek software has even earned Microsoft Gold Certification for its performance. The program was developed by CQA Solutions with programming support from NextSphere Technologies.

Technician using real-time Supertek software (CQA Solutions) on a tablet at a job site

More recently, CQA Solutions has converted its in-house training system for CQA technicians into a field-supporting, digitally based, training system. The CQA **Vendor Management Program** establishes paths to train up site employees and to recognize and specify staff quality. Glen Toepfer has referred to it as an "insurance policy for the geosynthetics industry."

LINING SYSTEMS

Raven Engineered Films Division openly provides a ready-to-use **pond liner calculator**-as a guide only, not for design or determining specification limits-based on a set of conditions. Users enter width, length, depth, anchor trench alloawance per side, and slop angle. The web-accessible calculator subsequently calculates an estimated liner size. The company manufactures a wide range of geomembrane liners. Each geomembrane has certain width criteria to be used in liner production, details which dictate what sizes are available to most closely, and most efficiently, meet estimated liner size outputs.



Pond liner calculator tool from Raven Engineered Films

Also from Raven, the free-to-use **Sandbag Calculator** web app estimates the number of sandbags needed to secure a liner in place during installation or for longer periods of exposure. Calculation options include length and width dimensions and total square footage of the lined area. Results include sandbags in the center and perimeter areas and total sandbags.

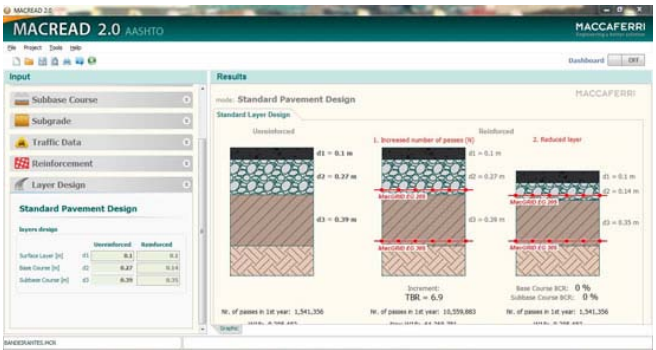
REINFORCEMENT: FOUNDATION IMPROVEMENT

Dimension® Solution Software calculates the bearing capacity and projected settlement beneath shallow foundations, which helps reduce project costs and improve foundation performance. Developed for Tensar International's Dimension® Foundation Improvement System, the program can help increase the effective bearing capacity by a factor of up to three (versus unimproved foundations); reduce estimated settlement up to 60%; mitigate differential settlement; and improve the margin of safety for unforeseen soil conditions. Learn more about the optimal soil and site conditions for the program and **request a copy here**.

REINFORCEMENT: PAVED & UNPAVED DESIGN

The **MacREAD package** from Maccaferri features key design approaches including the design of the road (or parking areas) foundation and the pavement reinforcement in different configurations (on soft soils, loose soils, with concentrated and distributed loads). It enables the user to optimize the relationship between construction layer thickness, fatigue life of the structure, and the use of geosynthetics, depending on the goals of the designer/project. The software has been fully updated into a suite of programs all related to soil stabilization and enables the verification, layer by layer, of the stress-strain requirements to be provided by the geosynthetic material to be used as the "stabilization" layer. Visit the **Design Software page on Maccaferri's website**, login, and access the resource.

NAUE's **SecuCalc 2.2** is a geogrid calculator tool for unpaved base reinforcement. SecuCalc 2.2 performs generic calculation of non-reinforced and geogrid-reinforced aggregate bases. Applications targeted by the design and cost estimation tool include roadway, access and haul road, parking lot, and similar designs. The user-friendly functionality takes into account specific site parameters and estimated material costs. The calculator details aggregate thickness, volume, and mass; area (m2) of reinforced soil; and design/system cost contrasts based upon the project-specific data. Request the free tool at **www.naue.com/en/secucalc**.



MacREAD from Maccaferri

MiraSpec software from Tencate Geosynthetics provides an analytical tool for engineers to design cost-effective flexible paved and unpaved roadways by incorporating geosynthetics. MiraSpec allows the designer to perform flexible pavement Structural Number (SN) and Equivalent Single Axle Load (ESAL) calculations based on the AASHTO 1993 design method and gravel thickness and cost savings comparisons using the Giroud-Han (2004) design method. Both sets of design calculations can be performed with or without geosynthetics. In addition, designers can calculate thickness reduction savings and "green" savings that the addition of a geosynthetic provides. Request the program at **http://www.miraspec.com**.

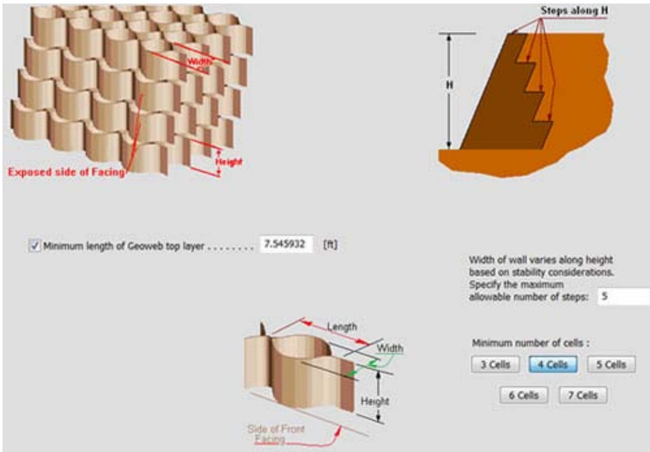
Tensar's **SpectraPave4-PRO™ Software (SP4-PRO)** provides pavement design engineers a powerful tool for evaluating design options and optimizing pavement performance. The software was developed for use with Tensar® Geogrids and the company's Spectra® Roadway Improvement System. With it, engineers can design for a specific level of performance, analyze support and loading conditions and serviceability limits, and compare designs and costs for unbound aggregate and mechanically stabilized aggregate layers. Includes subgrade stabilization and pavement optimization analysis. Available at no charge following completion of a free training module delivered by a Tensar specialist.

REINFORCEMENT: WALLS & SLOPES

Maccaferri's **MacSTARS** program is used to design reinforced soil slopes structures and walls (including segmental blockwork walls and vertical faced concrete panel structures). The software can also design soil-nailed slopes. Complex slope geometries and strata can easily be accommodated as well as the usual load cases including seismic conditions. The software enables the user to design in accordance with many of the worldwide design codes including ASTM methodology, EC7 and BS8006. Visit the **Design Software page on Maccaferri's website**, login, and access the resource.

NAUE opened 2016 with the release of **SecuSlope 3.0** for mechanically stabilized earth (MSE) applications. The program was fully updated for state-of-practice use with FHWA (limit equilibrium), BS 8006 (ultimate limit state), and Euro--Code 7 (EC7). SecuSlope software assists designs for geogrid-reinforced slopes, walls, and abutments. Using project-specific inputs, the program produces optimal geosynthetic reinforcement layouts, such as for length and spacing of layers. The program's recommendations are rooted in the extensive design record of Secugrid® geogrid reinforcement products. A free, downloadable version of SecuSlope 3.0 is available at **www.naue.com/en/secuslope**.

Geocellular confinement systems are increasingly used in mechanically stabilized earth (MSE) walls. PRESTO GEOSYSTEMS®, manufacturer of the well-known GEOWEB® soil stabilization and stormwater management products, introduced its **GEOWEB® MSE design freeware** in 2014. The program creates MSE designs for vegetated and non-vegetated walls, based on the GEOWEB® system for reinforced slopes and for gravity and geogrid-reinforced walls. The software is based on industry-standard design methods and contains specific algorithms that capture the unique interaction between the geocellular system, infill and backfill soil, and geogrid reinforcement and specific factors of safety. Analysis is performed with logical data input screens and full graphic design analysis output and cross-sectional drawings are created. Also connects to the company's SPEC-Maker® Tool. (See "SPECIFICATION" section)



A screenshot from GEOWEB® MSE design freeware from Presto Geosystems

With a 20+ year record of use, and frequently updated to meet newer codes, **TensarSoil® Software** from Tensar International is a fully interactive program that allows the user to input and alter project geometry, geogrid grade or layout, surcharge loads and/or soil characteristics to determine stability data and material costs instantly. **The latest version has been expanded** to evaluate the feasibility, potential performance, and cost benefits of each of the company's geogrid-reinforced systems, including the Mesa Retaining Wall Systems, SierraScape Retaining Wall Systems and Tensar Temporary Walls.

SPECIFICATION

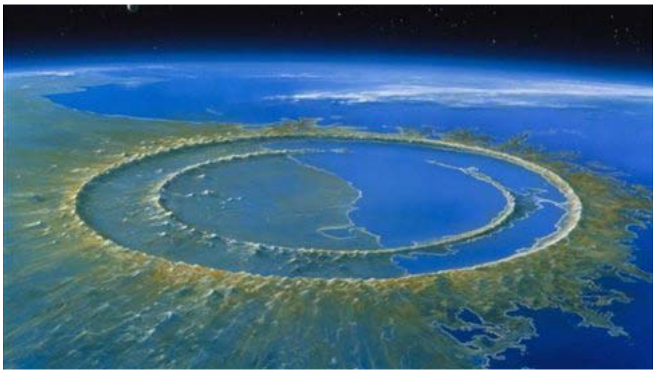
Presto Geosystems offers the convenient **SPECMaker® Tool**, an easy-to-use online program for quickly developing complete material and construction specifications. Through answering only a few essential questions, the program generates specifications that are tailored to your project application and details. It also saves the specification in the in CSI format in Word or HTML and enables additional modification. For field professionals utilizing geocellular systems and porous pavements, the SPECMaker® Tool is a time-saving asset. http://prestogeo.com/specmaker_tool

(Chris Kelsey / geosynthetica.net, June 9, 2016, http://www.geosynthetica.net/geosynthetic-design-software-calculator-tools)

Χρονικό του ολέθρου
Τι συνέβη την τελευταία μέρα των δεινοσαύρων

Συνέβη μια ωραία πρωία του Μεσοζωικού αιώνα, πριν από περίπου 66 εκατομμύρια χρόνια. Όλα ήταν ήσυχα στην περιοχή όπου βρίσκεται σήμερα η χερσόνησος Γιουκατάν του Μεξικού, με δεινόσαυρους και υπερμεγέθη έντομα να περιφέρονται στα κωνοφόρα δάση και τους βαλτότοπους του

Τσιξουλούμπ (σ.ε. Chicxulub). Μερικά δευτερόλεπτα αργότερα, όλα είχαν καταστραφεί.



Ο κρατήρας του Τσιξουλούμπ, διαμέτρου 185 χιλιομέτρων, έχει διαβρωθεί και σήμερα δεν διακρίνεται από την επιφάνεια (Καλλιτεχνική απεικόνιση: Detlev Van)

Ένας βράχος από το Διάστημα, μεγάλος σαν βουνό, πέφτει προς στη Γη με ταχύτητα 64.000 χιλιομέτρων την ώρα, και για μια στιγμή φαίνεται μεγαλύτερος και λαμπρότερος από τον Ήλιο καθώς σχίζει τον ουρανό. Μερικά κλάσματα του δευτερολέπτου αργότερα, συντρίβεται και απελευθερώνει ενέργεια που εκτιμάται στα 100 τρισεκατομμύρια τόνους TNT, ή ένα δισεκατομμύριο βόμβες σαν της Χιροσίμα.

Η πρόσκρουση σκάβει τον γήινοι φλοιό σε βάθος 30 χιλιομέτρων και δημιουργεί κρατήρα διαμέτρου 185 χιλιομέτρων. Εκατομμύρια κυβικά χιλιόμετρα πετρωμάτων εξαερώνονται και αρχίζουν ένα ντόμινο καταστροφής που εξαφανίζει το 75% των ζωντανών οργανισμών στη Γη, ανάμεσά τους και οι περισσότεροι δεινόσαυροι.

Η θεωρία της πρόσκρουσης διατυπώθηκε τη δεκαετία του 1980, ωστόσο η ανακάλυψη του κρατήρα του Τσιξουλούμπ στο Μεξικό τη δεκαετία του 1990 έδωσε για πρώτη φορά στους επιστήμονες μια εικόνα για το πού και το πότε, υπενθυμίζει το National Geographic.

Οι άμεσες επιπτώσεις του κομβικού βομβαρδισμού μπορούν να εκτιμηθούν με τον «υπολογιστή πρόσκρουσης» (http://purdue.edu/impactearth) που αναπτύχθηκε από γεωεπιστήμονες του Πανεπιστημίου «Πέρντιου» της Ιντιάνα και του Imperial College του Λονδίνου. Ο χρήστης εισάγει τις βασικές παραμέτρους, όπως το μέγεθος, η ταχύτητα και η γωνία πρόσκρουσης εισερχόμενου αντικειμένου, και το πρόγραμμα αναλαμβάνει να δώσει μια εικόνα των άμεσων συνεπειών.

«Μπορείς να εισάγεις διαφορετικές αποστάσεις από το σημείο πρόσκρουσης και να δεις πώς τα αποτελέσματα αλλάζουν ανάλογα με την απόσταση» εξηγεί στο National Geographic η Τζοάνα Μόργκαν, μέλος της βρετανικής ερευνητικής ομάδας που ανοίγει την πρώτη γεώτρηση στον κρατήρα του Τσιξουλούμπ.

«Αν βρισκόσουν κοντά, ας πούμε σε ακτίνα 1.000 χιλιομέτρων από την πρόσκρουση, θα σκοτωνόσουν ακαριαία ή μεσα σε λίγα δευτερόλεπτα» αναφέρει η ερευνήτρια.

Πράγματι, ο θάνατος θα ήταν βέβαιος για οποιονδήποτε βρισκόταν αρκετά κοντά για να δει την πύρινη σφαίρα, συμφωνεί ο Γκάρεθ Κόλινς, μέλος της ερευνητικής ομάδας που ανέπτυξε τον υπολογιστή πρόσκρουσης στο Imperial College.

Εννέα δευτερόλεπτα μετά την ώρα μηδέν, η θερμική ακτινοβολία της πρόσκρουσης τσιγαρίζει τον υποθετικό παρατηρητή μας. Οτιδήποτε μπορεί να καεί -θάμνοι, δέντρα και ολόκληρα δάση- φτάνει στο σημείο ανάφλεξης και πιάνει αυθόρμητα φωτιά από την ακτινοβολία.

Και μετά τη πυρκαγιά, έρχεται η ώρα, της πλημμύρας: ανάλογα με το ανάγλυφο της περιοχής, η πρόσκρουση πιστεύεται ότι σήκωνε τσουνάμι με ύψος μέχρι 305 μέτρα.

Σύμφωνα με συντηρητικές εκτιμήσεις, το τράνταγμα του κοσμικού χτυπήματος θα ξεπερνούσε τους 10,1 βαθμούς στην κλίμακα Ρίχτερ. «Ένα σεισμικό συμβάν αυτού του μεγέθους θα αντιστοιχούσε με το να εκδηλωθούν ταυτόχρονα όλοι οι σεισμοί του κόσμου τα τελευταία 160 χρόνια» λέει ο Ρικ Άστερ, καθηγητής Σεισμολογίας στο Πολιτειακό Πανεπιστήμιο του Κολοράντο και πρώην πρόεδρος της Σεισμολογικής Εταιρείας Αμερικής.

Περίπου 8 λεπτά μετά την ώρα μηδέν, συντρίμμια της πρόσκρουσης αρχίζουν να πέφτουν προς τη Γη, πνίγοντας τα πάντα σε ένα κάλυμμα από πυρωμένες πέτρες και στάχτη.

Περίπου 45 λεπτά αργότερα, ένας αφύσικος άνεμος χτυπά τον παρατηρητή με ταχύτητα 960 χιλιομέτρων την ώρα, ισοπεδώνοντας ό,τι είχε καταφέρει να μείνει όρθιο. Μαζί με τη ριπή φτάνει ο κρότος της πρόσκρουσης, ένα βιβλικό βουητό των 105 decibel, εκκωφαντικό σαν αεριωθούμενο που πετά σε χαμηλό ύψος.

Χιλιάδες χιλιόμετρα μακριά, σε περιοχές που παρέμειναν ασφαλείς από τις άμεσες επιπτώσεις, ο ουρανός πρώτα μαυρίζει από τον κουρνιαχτό και μετά φωτίζεται από συντρίμμια που εκτινάχθηκαν στο Διάστημα και μετά έπεσαν στην ατμόσφαιρα σαν πεφταστέρια.

«Δεν θα έμοιαζαν με κανονικούς διάττοντες αστέρες ή μετέωρα» εκτιμά ο Γκάρεθ Κόλινς του Imperial College. «Τα μετέωρα κινούνται με μεγαλύτερες ταχύτητες και καίγονται σε υψηλότερες θερμοκρασίες. Τα συντρίμμια θα εισέρχονταν στην ατμόσφαιρα σε μικρότερο ύψος και με μικρότερη ταχύτητα, εκπέμποντας κυρίως υπέρυθρη ακτινοβολία. Δεν είμαι σίγουρος με τι θα έμοιαζαν. Θα είχαν κάτι σαν κοκκινωπή λάμψη φαντάζομαι».

Σίγουρα θα πέρασε καιρός μέχρι να καθαρίσει η ατμόσφαιρα από την σκόνη. «Τις πρώτες ώρες το σκοτάδι θα ήταν σχεδόν απόλυτο» συνεχίζει ο Κόλινς. Για εβδομάδες, μήνες ή και χρόνια, ο πλανήτης έμεινε βυθισμένος στο ημίφως.

Κι όμως, μια απόκοσμη λάμψη διακρίνεται στον ορίζοντα. Πυρακτωμένα συντρίμμια που έπεσαν στο έδαφος προκαλούν πρωτοφανείς πυρκαγιές που τυλίγουν τη Γη και αφήνουν πίσω τους ένα στρώμα στάχτης, το οποίο παραμένει στα ιζήματα μέχρι και σήμερα ως μάρτυρας του μεγέθους της καταστροφής.

Όμως ο σημαντικότερος παράγοντας στη μαζική εξαφάνιση ειδών ήταν πιθανότατα το παγκόσμιο σκοτάδι, το οποίο μείωσε τη φωτοσύνθεση των φυτών σε δραματικά χαμηλά επίπεδα, και στέρησε έτσι από τη βασική πηγή τροφής τους τα περισσότερα μεγαλόσωμα ζώα.

Το φαινόμενο εκτιμάται ότι επιδεινώθηκε από τα θειούχα πετρώματα του Τσιξουλούμπ. Το θείο του υπεδάφους εκτινάχθηκε στην ατμόσφαιρα, αντέδρασε με υδρατμούς και σχημάτισε θειικό οξύ, το οποίο έπεσε στη Γη ως διαβρωτική βροχή από βιτριόλι.

Εκτός από θείο, όμως, τα ασβεστολιθικά πετρώματα του Τσιξουλούμπ πρέπει να απελευθέρωσαν κατά την πρόσκρουση γιγάντιες ποσότητες άνθρακα: δέκα δισεκατομμύρια τόνους διοξειδίου του άνθρακα, εκατό δισεκατομμύρια τόνους μονοξειδίου και ακόμα 100 δισεκατομμύρια τόνους μεθανίου, εκτιμά ο Ντέιβιντ Κριγκ, γεωλόγος του Lunar and Planetary Institute.

Όταν ο ουρανός καθάρισε, τα αέρια αυτά πιστεύεται ότι προκάλεσαν ένα ακραίο φαινόμενο θερμοκηπίου, ανεβάζοντας δραματικά τη θερμοκρασία για δεκαετίες ή αιώνες.

Κοντολογίς, αιτία της μαζικής εξαφάνισης ήταν το διπλό χτύπημα ενός πυρηνικού χειμώνα, τον οποίο ακολούθησε ένα επεισόδιο ακραίας παγκόσμιας θέρμανσης.

Υπάρχουν ωστόσο και εναλλακτικές θεωρίες, σύμφωνα με τις οποίες η εξαφάνιση των δεινόσαυρων προκλήθηκε από την πρόσκρουση του Τσιξουλούμπ σε συνδυασμό με άλλους παράγοντες όπως γιγαντιαίες ηφαιστειακές εκρήξεις.

Ό,τι κι αν συνέβη, το αρχείο των απολιθωμάτων μαρτυρά ότι τουλάχιστον επτά στα δέκα είδη του πλανήτη εξαφανίστηκαν, συμπεριλαμβανομένων όλων των τετράποδων ζώων με βάρος άνω των 25 κιλών.

Υπήρχαν όμως και αυτοί που επέζησαν της παγκόσμιας καταστροφής. Ανάμεσά τους μια ομάδα δεινόσαυρων που είχαν μάθει να πετούν, και ήταν οι πρόγονοι όλων των σημερινών πτηνών.

Και αυτό σημαίνει ότι, αντίθετα με την ευρέως διαδεδομένη άποψη, η πρόσκρουση του Τσιξουλούμπ δεν εξαφάνισε όλους τους δεινόσαυρους.

Μερικοί πετούν σήμερα ανάμεσά μας, απόγονοι των ηρωικών επιζώντων.

(Βαγγέλης Πρατικάκης / Newsroom ΔΟΛ, 13 Ιουν. 2016, http://news.in.gr/science-technology/article/?aid=1500083945)

Here's What Happened the Day the Dinosaurs Died

An impact calculator helps scientists paint a vivid picture of the immediate aftermath of the deadly asteroid strike.

Imagine sunrise on the last day of the Mesozoic era, 66 million years ago. Shafts of sunlight rake through the swamps and coniferous forests along the coast of what is now Mexico's Yucatán Peninsula. The blood-warm seas of the Gulf of Mexico teem with life.

As this lost world of dinosaurs and outsize insects squawks and buzzes and whirs to life, an asteroid the size of a mountain is hurtling toward Earth at about 40,000 miles (64,000 kilometers) an hour.

For a few fleeting moments, a fireball that appears far bigger and brighter than the sun streaks through the sky. An instant later, the asteroid slams into Earth with an explosive yield estimated at over 100 trillion tons of TNT.

The impact penetrates Earth's crust to a depth of several miles, gouging a crater more than 115 miles (185 kilometers) across and vaporizing thousands of cubic miles of rock. The event sets off a chain of global catastrophes that wipe out 80 percent of life on Earth—including most of the dinosaurs.

This apocalyptic tale has been described in countless books and magazines ever since the asteroid impact theory was first put forth in 1980. The identification of Chicxulub Crater in the Gulf of Mexico during the 1990s then gave scientists an accurate idea of the "when" and the "where."

But exactly how the fallout killed off so much life on Earth has remained a tantalizing mystery.

Last month, a team of British scientists working on an offshore drilling platform in the Gulf of Mexico obtained the first-ever core samples from the "peak ring" of the Chicxulub Crater. This ring is where the shocked Earth rebounded in the seconds following the impact, and the swelling formed a large circular structure within the crater walls. By studying its topsy-turvy geology, researchers hope to gain a better understanding of the phenomenal forces unleashed that day.

This is a piece of the asteroid that made the Chicxulub Crater.

Reliving Catastrophe

What is already known would beggar the imaginations of Hollywood scriptwriters. Using an "impact calculator" developed by a team of geophysicists from Purdue University and Imperial College London, users can enter in a few key details, such as the asteroid's size and speed, to paint a vivid picture of events.

"You can plug in different distances from the point of impact to see how the effects change over distance," says Joanna Morgan, one of the lead scientists on the Chicxulub drilling project. "If you were close by, say within 1,000 kilometers [625 miles], you would be instantaneously, or within a few seconds, killed by the fireball."

Indeed, if you were near enough to see it, you were dead, says Gareth Collins, a lecturer on planetary science at Imperial College who helped develop the program.

Nine seconds after impact, an observer at that distance would have been roasted by a blast of thermal radiation. Trees, grass, and shrubs would have spontaneously burst into flame, and anyone present would have suffered instant third-degree burns over their entire bodies.

After the fire comes the flood. Depending on the local topography, the impact would have kicked up a phenomenal tsunami up to 1,000 feet (305 meters) high. And at the low-end estimate of 10.1 on the Richter scale, the subsequent earthquake would have been more powerful than anything ever measured or experienced by humans.

"A seismic event of this size would be the equivalent of all the world's earthquakes for the past 160 years going off simultaneously," says Rick Aster, professor of seismology at Colorado State University and former president of the Seismological Society of America.

At just over eight minutes post-impact, ejecta would start to spill down, smothering the burning landscapes beneath a blanket of hot grit and ash. Closer to the impact zone, the ground would be buried beneath hundreds, even thousands, of feet of rubble.

About 45 minutes later, a blast of wind would tear through the region at 600 miles (965 kilometers) an hour, scattering debris and leveling anything that might still be standing. The sound of the explosion would arrive at the same time, a 105-decibel roar as deafening as a jet making a low pass flyover.

Further afield, out of range of the direct effects of the explosion, an observer would be treated to the spectacle of darkening skies and an apocalyptic display of shooting stars created by the impact debris raining back on Earth.

These rocks were brought up by scientists from the Chicxulub Crater.

"They wouldn't have looked quite like regular shooting stars or meteors," says Collins. "Meteors burn up at higher speeds and get hotter. These would have been re-entering the atmosphere at lower altitudes, traveling slower and emitting infrared radiation. I'm not entirely sure what that would look like. Some sort of red glow would be my guess."

After the red glow, the sky would darken as ash and debris swirling around the globe created a creeping twilight.

"For the first few hours, there would have been close to total darkness," says Collins. "But soon after that, the sky would begin to lighten. The following weeks, months perhaps even years were probably somewhere between twilight and a very cloudy day."

End Times

While most accounts focus on the spectacular violence of those first few minutes to days after the impact, it was the long-term environmental effects that ultimately wiped out most dinosaurs and much of the rest of life on Earth.

The prevailing dimness caused by the dust cloud meant photosynthesis would have been dramatically reduced. The soot and ash would have taken months to wash out of the atmosphere, and when it did, the rain would have fallen as acidic mud. Massive fires would have produced huge amounts of toxins that temporarily destroyed the planet's protective ozone layer.

Then there was the carbon footprint of the impact itself, which released an estimated 10,000 billion tons of carbon dioxide, 100 billion tons of carbon monoxide, and another 100 billion tons of methane in one fell swoop, according to geologist David Kring of the Lunar and Planetary Institute.

In effect, the aftermath of the asteroid was probably a powerful one-two punch of nuclear winter followed by dramatic global warming. And that's where the core samples freshly pulled from Chicxulub Crater can help fill in gaps in this infamous story.

"The drilling program will help us understand how all this affected the post-impact climate—how much material was ejected into the stratosphere and what that material was," says Morgan.

(Roff Smith, June 11, 2016, http://news.nationalgeographic.com/2016/06/what-happened-day-dinosaurs-died-chicxulub-drilling-asteroid-science)

Dr.Hoek's Lecture Series

Rocscience is happy to announce the release of the latest videos in Dr. Hoek's Lecture Series.

Dr. Hoek has published extensively, including three books, and plans to continue adding to and updating the material available in Hoek's Corner on the Rocscience website (https://www.rocscience.com/learning/hoek-s-corner).

We are proud to present the Distinguished Lecture Series videos (https://www.rocscience.com/learning/hoek-s-corner/lecture-series), which cover different topics in Rock Mechanics Engineering. If you missed the first four videos, the links are found below:

Lecture #1: The Development of Rock Engineering
https://www.youtube.com/watch?v=r0ezG4SmaXM
Lecture #2: The Art of Tunneling in Rock
https://www.youtube.com/watch?v=RDDoBECOUf4
Lecture #3: Intact Rock Sampling and Testing
https://www.youtube.com/watch?v=wAame7W5F50
Lecture #4: Rock Mass Properties
https://www.youtube.com/watch?v=pgIjAXKyPWY&feature=youtu.be

The latest lectures are included here:

Lecture #5: Rock Slope Engineering Rock slope engineering involves the assessment of the risk of instability, the consequences of failure and remedial measures that can be taken in stabilizing rock slopes. Rockfalls pose different kinds of risks and these are also discussed briefly.

Watch the video: Rock Slope Engineering
https://www.youtube.com/watch?v=1c0W01jUrRM

Lecture #6: Large Underground Excavated Caverns The stability of large excavated caverns for underground powerhouses, metro stations and other facilities require careful design as well as precisely sequenced excavation and support installation. The most significant steps in the design and construction process are discussed in this lecture.

Watch the video: Large Underground Excavated Caverns
https://www.youtube.com/watch?v=jrwnB5JiWFQ

(RocNews Summer 2016)

GEOBUUK - Selection of videos about Geotechnical Engineering

Dear colleagues,

I am developing a website with a good selection of videos related to Geotechnical Engineering. The goal is to have a dynamic site where the information can be easily filtered by subjects and construction techniques.

I think GEOBUUK can be a good tool for this Group, so I am happy to share it with all of you. I hope you enjoy the website and do not hesitate to contact me if you have suggestions.

http://geobuuk.com

Gerardo Marote Ramos
Engineering and Resources Director at Terratest Group

ΝΕΕΣ ΕΚΔΟΣΕΙΣ ΣΤΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΠΙΣΤΗΜΕΣ

Υποστήριξη Υπογείων Έργων

Αλέξανδρος Σοφιανός

Το υλικό που παρουσιάζεται προέκυψε από την επεξεργασία μιας σειράς διαλέξεων αρχικά προετοιμασμένων για τη διδασκαλία του ομώνυμου μαθήματος σε προπτυχιακούς φοιτητές της Σχολής Μηχανικών Μεταλλείων-Μεταλλουργών του ΕΜΠ. Στο κείμενο γίνεται αναφορά σε υπολογιστικές μεθόδους για την ανάλυση των τάσεων και μετατοπίσεων στη βραχομάζα και στα μέτρα στήριξης. Αυτές βασίζονται τόσο σε κλειστές λύσεις όσο και σε κώδικες πεπερασμένων στοιχείων ή διαφορών, οριακών και διακριτών στοιχείων που εφαρμόζονται στην καθημερινή πρακτική μελέτης των υπόγειων έργων και διατίθενται από διαφόρους οίκους λογισμικού. Το κείμενο έχει ως στόχο να αντιμετωπίσει πολλά από τα θέματα στήριξης υπογείων έργων που προκύπτουν κατά την εξόρυξη μεταλλευτικών και τεχνικών έργων. Εντούτοις, πολύ περισσότερα από τα αντικείμενα της μηχανικής των διαφόρων μεθόδων εκμετάλλευσης και της στήριξής τους δεν μπόρεσαν να χωρέσουν στα περιεχόμενα αυτού του συγγράμματος. Εκτιμάται, όμως, ότι το περιεχόμενο υλικό δίνει στον αναγνώστη το υπόβαθρο που απαιτείται, ώστε αυτός να μπορεί να παρακολουθήσει σε επόμενα συγγράμματα τη μηχανική της συμπεριφοράς και άλλων μεθόδων υπογείων διανοίξεων ή εκμεταλλεύσεων. Το σύγγραμμα είναι κατάλληλο για παρουσίαση σε τελειόφοιτους φοιτητές μεταλλειολόγους και γεωτεχνικούς πολιτικούς μηχανικούς, καθώς και για τα αρχικά στάδια μεταπτυχιακής εκπαίδευσης σε αυτά τα αντικείμενα. Χρήσιμο επίσης θα είναι σε διπλωματούχους μηχανικούς που εμπλέκονται στον σχεδιασμό μεταλλείων και τεχνικών έργων.

Πρόσβαση στο βιβλίο σε μορφή pdf μέσω του συνδέσμου http://www.tunnelling.metal.ntua.gr/index.pl/underground_support

(Ελληνικά Ακαδημαϊκά Ηλεκτρονικά Συγγράμματα και Βοηθήματα, www.kallipos.gr, 2016)

PAS 8810:2016 Tunnel design - Design of concrete segmental tunnel linings – Code of practice

Segmental tunnel linings are currently designed with reference to a large number of standards and documents. PAS 8810 brings all of these together into a single, usable standardisation document that aims to reduce unnecessary administration and delay by streamlining, clarifying and standardising the design process for segmental lining design.

PAS 8810 is a publicly accessible standard published by the British Standards Institution that documents recommendations and codes of practice for the design of concrete segmental tunnel linings. It covers design considerations from project inception through to the end of the service life of the tunnel. At the early stage of the design, the study of the options for the selection of the tunnel lining is not limited to concrete segmental tunnel linings. So, Clauses 4 to 8 in the PAS cover the general aspects of tunnel design and Clauses 9 to 12 give specific, technical recommendations on precast concrete lining elements for segmental tunnel linings.

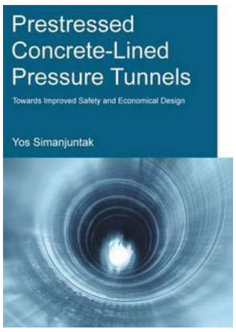
PAS 8810 sets out detailed recommendations as referred to by existing national and international industry standards. It also includes specific design recommendations for the design items not available in any other standards. PAS 8810 covers:

- Functional requirements
- Conceptual design
- Characterisation of ground
- Materials design and specification
- Material characterisation and testing
- Limit state design
- Concrete segmental lining design
- Concrete segment lining modelling
- Instrumentation and monitoring
- Design management

This PAS does not cover:

- Sprayed concrete lined tunnels
- Cast insitu concrete lined tunnels
- Any tunnel lining using material other than concrete, such as spheroidal graphite iron or steel
- Cut and cover tunnels
- Drill+blast excavations
- Hard rock tunnelling
- Pipejacking
- Project planning and management

(British Standards Institution, April 2016)



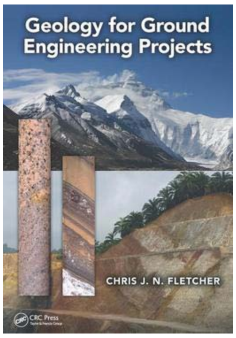
Prestressed Concrete-Lined Pressure Tunnels: Towards Improved Safety and Economical Design

T.D.Y.F. Simanjuntak

Hydropower can be a source of sustainable energy, provided environmental considerations are taken into account and economic aspects of hydropower design are appropriately addressed. Using concrete-lined pressure tunnels instead of steel pipes may be economically attractive but may also have limitations due to the low tensile strength of concrete.

Cracking in concrete tunnel linings can lead to loss of energy production, extensive repairs, and even accidents. One of the techniques available to improve the bearing capacity of pressure tunnels is through prestressing the concrete lining by grouting the circumferential gap between the concrete lining and the rock mass at high pressure. A classical approach to determine the bearing capacity of such tunnels is based on the theory of elasticity, assuming impervious concrete. In this research, a new concept is introduced to assess the effect of seepage on the bearing capacity of pressure tunnels. Also, an innovative approach is proposed to explore the effects of the in-situ stress ratio on the lining performance. Distinction is made based on whether the rock mass behaves as an elasto-plastic isotropic, or elastic anisotropic material. Furthermore, a simplified method is introduced to quantify seepage associated with cracks around the tunnel, which is useful for assessing tunnel stability. The book is based on the PhD research of the author.

(CRC Press, 28 July 2015)



Geology for Ground Engineering Projects

Chris J. N. Fletcher

Geology for Ground Engineering Projects provides a comprehensive presentation of, and insight into, the critical geological phenomena that may be encountered in many engineering projects, for example rock contact relationships, weathering and karst phenomena in tropical areas, composition of fault zones and variability of rock discontinuities. Examples are provided from around the world, including Southeast Asia, Europe, North and South America, China and India.

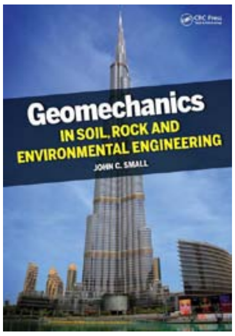
Comprehensive and well-illustrated, this definitive book:

- Describes the important geological phenomena that could affect ground engineering projects
- Provides a practical knowledge-base for relevant geological processes
- Addresses common geological issues and concerns

Rocks are described in relation to the environment of their formation, highlighting the variation in composition, distribution and geotechnical properties that can be expected within a variety of rock associations. Case studies, where geology has been a vital factor, are included. These are written by the project engineers or geologists responsible for the projects. Readers are directed to satellite images of selected areas to explore for themselves many of the geological features described in the book.

Author Chris Fletcher is a consulting geologist, based in Wales. He graduated from St Andrew's University in Scotland, and then moved to Canada to complete an MSc at Queen's University and a PhD at the University of British Columbia. Most of his career has been with the British Geological Survey, both in the UK and overseas. He then became director of the Hong Kong Geological Survey and later managed his own geological consulting company. He was an Honorary Professor at universities in Hong Kong and China, where he presented graduate and professional development courses.

(CRC Press, 20 June 2016)



Geomechanics in Soil, Rock, and Environmental Engineering

John Small

Aimed at course instructors as a practical and advanced-level textbook, *Geomechanics in Soil, Rock, and Engineering Practice* is deeply rooted in engineering practice and would also suit practising engineers as a reference guide, or students in their final undergraduate course in geomechanics/master's-level students.

Modern practice in geomechanics is becoming increasingly reliant on computer-based software, much of which can be obtained through the Internet. In *Geomechanics* the application of these numerical techniques is examined not only for soil mechanics, but also for rock mechanics and environmental applications.

The book deals with the modern analysis of shallow foundations, deep foundations, retaining structures, and excavation and tunnelling. Many fresh solutions to problems are presented to enable more accurate and advanced designs to be carried out.

Utilising both computer and hand-based calculations, Geomechanics incorporates the author's more than 40 years of academic and practical design experience.

(CRC Press, 9 March 2016)

ΗΛΕΚΤΡΟΝΙΚΑ ΠΕΡΙΟΔΙΚΑ

No. 34 - June 2016
www.isrm.net/adm/newsletter/ver_html.php?id_newsletter=126&ver=1

Κυκλοφόρησε το τεύχος αρ. 34, Ιουνίου 2016 του NEWSLETTER της ISRM με τα ακόλουθα περιεχόμενα:

- President's Letter
- 14th ISRM online lecture by Prof. Walter Wittke
- 2016 ISRM International Symposium
- ARMS9, Bali, Indonesia, 18-20 October 2016
- Rock Mechanics Principles, a video course by Professor Jian Zhao
- 2017 ISRM International Symposium - AfriRock October 2017, Cape Town, South Africa
- EUROCK 2017, June 2017, Ostrava, Czech Republic
- ISRM Rocha Medal 2018 - nominations to be received by 31 December 2016
- 2nd ISCSR, 6-7 October, Cartagena, Colombia, an ISRM Specialised Conference
- VIII SBMR, 19-22 October 2016, Belo Horizonte, Brazil, an ISRM Specialised Conference
- RARE-2016, 16-18 November, Bengaluru, India, an ISRM Specialised Conference
- ISRM Sponsored Meetings
- 50th US Rock Mechanics/Geomechanics Symposium
- RS2016 – 7th International Symposium on In-Situ Rock Stresses was held in Tampere, Finland
- Geosafe 2016 was held in Xi'an, China
- RockDyn-2 was held in Suzhou, China

☙ ❧

www.geoengineer.org

Κυκλοφόρησε το Τεύχος #135 του **Newsletter του Geoengineer.org** (Ιουνίου 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).

☙ ❧

Newsletter #24 - June 2016
www.itacet.org/Newsletter/24_2016/documents/NL_24_June_2016.pdf

Κυκλοφόρησε το Τεύχος 24 (Ιουνίου 2016) με τα παρακάτω περιεχόμενα:

- The word of the President
- Editorial: Tarcisio Celestino, ITA-AITES President
- Interview: Michel Defayet, Director CETU, Lyon
- Awards 2016
- Coming soon:
  - Life-cycle Management of Tunnels
  - Mechanized Tunnelling in Soft Ground
  - Risk Management
  - Planning & Design in Conventional Tunnelling
  - Health & Safety & Logistic in Tunnel Construction
- Next events in preparation:
  - Risk and Contracts on >12-13 November 2016 - Malaysia
  - Tunnelling in Soft Ground on 17-18 November 2016 – Mexico
  - Sustainable Tunnelling – 11-12 December 2016 –Saudi Arabia
- Events Report
  - Pre WTC training sessions for continuing education 22-24 April 2016, San Francisco, California
    MONITORING AND CONTROL IN TUNNELLING
    UNDERGROUND SPACE USE
- News from our Sponsored Master Students

ΕΚΤΕΛΕΣΤΙΚΗ ΕΠΙΤΡΟΠΗ ΕΕΕΕΓΜ (2015 – 2018)

ΕΕΕΕΓΜ

Τομέας Γεωτεχνικής
ΣΧΟΛΗ ΠΟΛΙΤΙΚΩΝ ΜΗΧΑΝΙΚΩΝ
ΕΘΝΙΚΟΥ ΜΕΤΣΟΒΙΟΥ ΠΟΛΥΤΕΧΝΕΙΟΥ
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