



## International Society for Soil Mechanics and Geotechnical Engineering

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## Research highlights

### Centre for Soft Ground Engineering (CSGE), National University of Singapore (NUS)

The research activities at the National University of Singapore (NUS) Centre for Soft Ground Engineering (CSGE) are grouped into two main areas, namely urban geotechnics and offshore geotechnics, both of which are reflected in the Singapore government's Research Innovation and Enterprise Plan up to 2020 (RIE2020). The focus of urban geotechnics is captured under the "Urban Solutions and Sustainability (USS)" thrust of the RIE2020, which include creating and optimizing liveable space. Within CSGE, this is translated into several research thrusts including underground construction, ground improvement, land reclamation and coastal protection as well as risks and hazards arising from man-made and natural catastrophes.

A particularly important aspect of urban geotechnics in Singapore is large-scale underground development. In many large cities, usable space is a premium resource and underground development is often more a matter of necessity rather than choice. Singapore is an extreme example of this since it is completely surrounded by sea. The need for large-scale underground development is not new. This is captured in the Economics Strategies Committees' Report (2010), which noted that we need to *"...adopt a long term perspective and invest ahead to create new land and space."* While we can expand our land mass through reclamation as we have done for Marina Bay, there will be limits in the long-run. In the next 10 years, the Government should seek to catalyse the development of underground space as a means to intensify land use. We should put in place enablers for underground development such as by developing a subterranean land rights and valuation framework, and by establishing a national geology office. We must also develop an underground masterplan to ensure that underground and aboveground spaces are synergised, and invest in the creation of basement spaces in conjunction with new underground infrastructural projects (e.g. rail), so as to add to our "land bank".

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This forms the backdrop of a substantial and long-term “space creation” programme which is driving a significant part of the geotechnical research strands in CSGE.

The impetus for the need to create space on geotechnical research at CSGE is reflected in the following strands of research work:

- (a) Deep excavation and underground construction: Fook-Hou Lee, Chun-Fai Leung, Yean-Khow Chow, Kwet-Yew Yong and Harry Siew-Ann Tan.
- (b) Land reclamation and coastal development: Darren Siau-Chen Chian and Soon-Hoe Chew.
- (c) Ground improvement: Fook-Hou Lee, Darren Siau-Chen Chian, Kwet-Yew Yong and Soon-Hoe Chew.
- (d) Site investigation and ground characterization: Kok-Kwang Phoon and Taeseo Ku.
- (e) Impact of earthquakes and ground vibration on subterranean structures: Siang-Huat Goh and Darren Siau-Chen Chian.

The need for offshore geotechnics, as a part of marine and offshore engineering, is also reflected in one of the RIE2020's Strategic Technology Domains “Advanced Manufacturing and Engineering”, under which “marine and offshore” is one of eight key industry pillars. The Singapore Maritime Institute (SMI) currently co-ordinates all marine and offshore research activities in Singapore. Within NUS, research activities in this sector are co-ordinated by the Maritime Institute@NUS (MI@NUS), the Director for which is Professor Yean-Khow Chow. The offshore geotechnical research work at NUS covers the following topics:

- (i) Spudcan foundations: Yean-Khow Chow, Chun-Fai Leung and Fook-Hou Lee.
- (ii) Plate and dynamically installed anchors: Yean-Khow Chow, Chun-Fai Leung and Fook-Hou Lee.
- (iii) Deepwater pipelines: Fook-Hou Lee.

More details on the research works can be found in the write-ups of the respective researchers.

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#### Fook-Hou Lee

Fook-Hou Lee is a professor in the Department of Civil & Environmental Engineering, where he developed the NUS Geotechnical Centrifuge. He is also the co-chairman of the National University of Singapore-Ministry of Defence Centre for Protective Technology (CPT) as well as the director of the Department's Centre for Soft Ground Engineering (CSGE). He is an editorial board member for several international journals and Managing Editor for the Journal of Earthquake and Tsunami. He is also a member of the World Federation of Engineering Organization Committee Engineering and The Environment Task Group on Disaster Risk Management (DRM/WFEO-CEE). He is a Fellow of the Singapore Academy of Engineering, as well as a registered Professional Civil Engineer and Professional Geotechnical Specialist Engineer.



In the area of geotechnics, Fook-Hou's primary research interest lies in soil improvement, especially in relation to urban and underground construction. His earlier works on this area dealt mainly with sand compaction piles and dynamic compaction, which were more relevant to land reclamation. With the shortage of sand for reclamation works in Singapore, and the resulting shift in national attention to underground space creation, his research efforts is currently directed towards cement treatment, principally deep cement mixing (DCM). Although DCM has been in use for several decades, much remains unknown about the mass performance of the treated ground, especially in relation to its use in underground construction. Fook-Hou's research is currently directed towards the development of technology which will allow engineers to design, implement and quality control DCM for underground construction more efficiently and innovatively. His research thrusts in this area lie mainly in the following aspects of DCM:

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1. Constitutive behaviour and modelling. The earlier works on compressive strength and micro-structure of cement-admixed clay has been extended to cover yielding and post-yield behaviour, tensile strength, compression behaviour under very low effective stress, small strain non-linear behaviour as well as the effect of the inclusion of random fibres into cement-soil matrix (Huawen Xiao, Jiahui Ho, Yutao Pan and Kai Yao). A constitutive model for cement-admixed clay based on an extension of the Cam Clay energy equation to include the effect of cementation and loss of cementation has just been published (Huawen Xiao). This is currently being extended to include the effect of fibre-reinforcement in the cement-soil matrix (Yannick Ng). A central idea in this development is that the loss of cementation can be quantified through the energy dissipated within the cement-soil matrix.
2. Spatial variability of the cement-treated ground. An important feature of cement-treated ground is its non-uniformity. Recent centrifuge model and field data study by his researchers (Chen-Hui Lee, Jian Chen, Yong Liu, Yijie Jiang, Linqiao He) indicate that this spatial variability can be explained by quality of mixing (intra-column variability with short scale-of-fluctuation), natural variation in soil state especially in-situ moisture content (inter-column variability with long scale-of-fluctuation) as well as workmanship especially positioning error and off-verticality in the mixing equipment. The non-uniformity in cement content is accentuated by the non-linear relationship between cement and water contents and treated soil strength. As a result, the strength of the treated soil often shows greater spatial variation than the cement content. Recent and on-going research activities also revolve around the effect of these spatial variation on the mass strength of the treated ground (Yong Liu, Yutao Pan, Muhammad Faizal bin Zulkefli, Kai-Qi Tan, Akanksha Tyagi) using random finite element analyses, Fig. 1. The cement-treated soil is often assessed by strength testing of core samples. Recent works have also led to statistical guidelines on the number of core samples which are required to ensure adequate representation of the treated soil mass, as well as methods of evaluating representative properties from these cores.

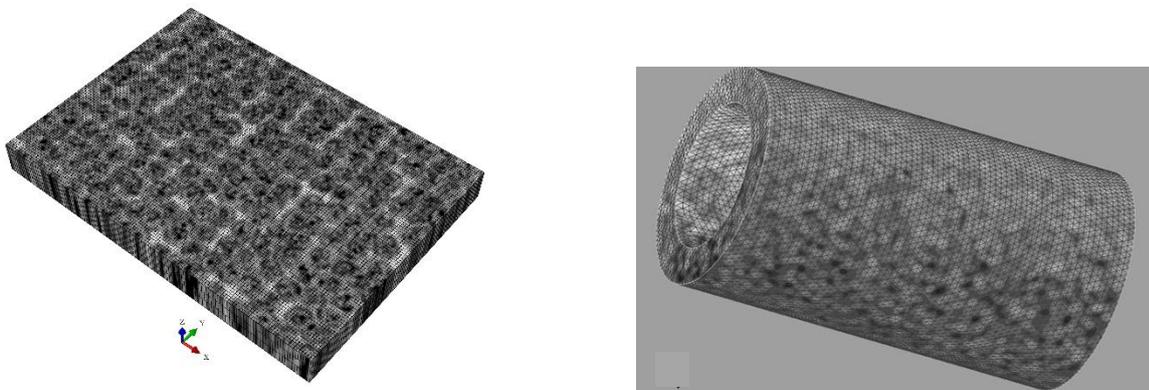


Figure 1. Random finite element analysis of cement-treated soil slab and tunnel

3. Computational tools. Computational tools have also been developed to facilitate the computational demands of random finite element analyses (Yong Liu, Ben Zhao). These include the incorporation of random finite element capabilities, multi-core and multi-computer parallel processing (using MPI) into GeoFEA (GeoSoft Pte. Ltd.). Highly convergent Krylov subspace solution techniques and global and local equilibration processes have also been incorporated into the code to allow progressive failure of highly non-uniform domains to be studied (Ben Zhao).

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4. Failure of tunnels and headings with cement-treated soil surrounds. Physical model studies are also being conducted into the failure of tunnels and headings with cement-treated soil surrounds (Muhammad Faizal bin Zulkefli, Kai-Qi Tan, Akanksha Tyagi), Fig. 2. Although these models do not reflect the spatial variability of actual improved soil domains, they nonetheless give an indication into the failure behaviour of cement-treated soil masses and provide data for validation of numerical results. The failure mode study shows that collapse can occur either by shear or tensile fracture, depending upon the mode of loading, thickness:diameter ratio and the strength of the treated soil zone relative to that of the surrounding soft soil.

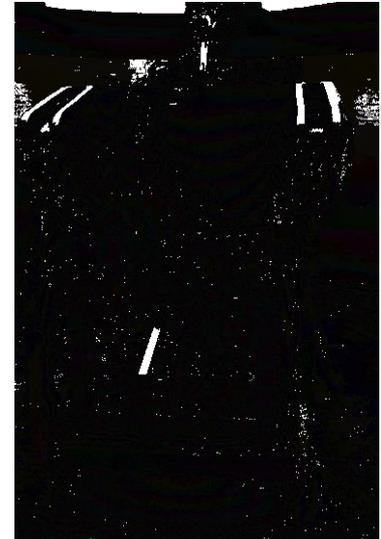


Fig. 2. Centrifuge modelling of tunnels with improved soil surround and heading

5. Construction technologies. The feasibility of pumping and mixing fibres deep into the ground is also studied as part of the research activities (Chong-Hun Yeo, Hui-Juen Teo and Chujun Zhang). The results to date suggest that it is feasible to pump fibres into the ground, although there may be a degradation in the mixing quality. In addition, a joint has also been developed which will enable deep mixing to be conducted around corners and potentially allow regions obstructed by overlying obstacles and infrastructures to be treated, Fig. 3. A full prototype is being developed (Liang-Hong Tay, Qingsheng Chen).



Fig. 3. Field test on an equipment for deep mixing around corners and obstacles

## Kok-Kwang Phoon

Kok-Kwang Phoon, PhD, PEng, FSEng, FIES, FASCE is Distinguished Professor and Vice Provost (Academic Personnel) at the National University of Singapore. He is a Professional Engineer in Singapore, an ASEAN Chartered Professional Engineer, and past President of the Geotechnical Society of Singapore. He was elected Fellow of the Academy of Engineering Singapore (FSEng) in 2012.

Dr. Phoon received his BEng (First Class Honours) and MEng from the National University of Singapore and his PhD from Cornell University where his research on reliability-based design has influenced recent codes and specifications, including the 4<sup>th</sup> edition of ISO2394:2015, *General Principles on Reliability for Structures*. Dr. Phoon's main research focus is on risk and reliability in geotechnical engineering. He is the lead editor of 3 books: *Reliability-Based Design in Geotechnical Engineering* (Spon Press, 2008), *Risk and Reliability in Geotechnical Engineering* (CRC Press, 2015), and *Reliability of Geotechnical Structures in ISO2394* (CRC Press/Balkema, 2016).



## Research highlights

### Centre for Soft Ground Engineering (CSGE), National University of Singapore (NUS) (Con't)

Dr. Phoon has been active in coordinating and promoting geotechnical risk analysis and reliability-based design codes. He is current Chair of TC304 - Engineering Practice of Risk Assessment and Management, International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE). He was past Chair of the Geo-Institute Technical Committee on Risk Assessment and Management.

Dr. Phoon's recent research efforts have been directed towards injecting greater realism into geotechnical reliability-based design (RBD), particularly in the characterization of multivariate soil databases and in the development of information-sensitive yet practical RBD that links data explicitly to design. The "value of information" can thus be quantified. It is easier for engineers to present site investigation as an investment rather than a cost to clients when project needs are complemented by a quantitative notion of "value of information". This is arguably the most significant value that RBD brings to current practice. Two main activities in this direction are highlighted below.

1. Characterization of geotechnical variability. Site investigation and the interpretation of site data are necessary aspects of sound geotechnical practice. Any design methodology, be it RBD or otherwise, should place site investigation as the cornerstone of the methodology. Site investigation is also the key feature that distinguishes geotechnical from structural design practice. Phoon and Kulhawy (1999) presented an extensive compilation of univariate soil data, covering data produced by many common laboratory and field tests. Soil databases covering more than one parameter have also been compiled recently as summarized in the table below. These databases are exceedingly useful. They can be used by the engineer as prior information to update more limited site specific data, which is the norm in practice. They can be used by the code writer for reliability calibration of resistance/partial factors. Fundamentally, a design methodology that is sensitive to the quantity and quality of geotechnical information would redress the balance that is presently tilted towards keeping site investigation efforts to a minimum. The contributions of the collaborators, particularly Dr Jianye Ching from the National Taiwan University, are acknowledged in the cited publications.

#### Multivariate soil databases

Database	Reference	Soil parameters	# data points	# sites/studies	Range of properties		
					OCR	PI	$S_t$
CLAY/5/345	Ching and Phoon (2012)	LI, $s_u$ , $s_u^{re}$ , $\sigma'_p$ , $\sigma'_v$	345	37	1-4		Sensitive to quick clays
CLAY/6/535	Ching et al. (2014)	$s_u/\sigma'_v$ , OCR, $(q_t-\sigma'_v)/\sigma'_v$ , $(q_t-u_2)/\sigma'_v$ , $(u_2-u_0)/\sigma'_v$ , $B_q$	535	40	1-6	Low to very high plasticity	Insensitive to quick clays
CLAY/7/6310	Ching and Phoon (2013)	$s_u$ under 7 different test modes	6310	164	1-10	Low to very high plasticity	Insensitive to quick clays
CLAY/10/7490	Ching and Phoon (2014)	LL, PI, LI, $\sigma'_v/P_a$ , $\sigma'_p/P_a$ , $s_u/\sigma'_v$ , $S_t$ , $(q_t-\sigma'_v)/\sigma'_v$ , $(q_t-u_2)/\sigma'_v$ , $B_q$	7490	251	1-10	Low to very high plasticity	Insensitive to quick clays
CLAY/4/BN	Ching et al. (2010)	OCR, $s_u$ , $N_{60}$ , $(q_t-\sigma'_v)/\sigma'_v$	-	-	1-50	-	-
F-CLAY/7/216	D'Ignazio et al. (2016)	$s_u$ , $\sigma'_p$ , $\sigma'_v$ , LL, PL, $w_n$ , $S_t$	216	24	1-8	Low to very high plasticity	Insensitive to quick clays
SAND/4/BN	Ching et al. (2012)	$D_r$ , $\phi'$ , $(N_1)_{60}$ , $q_{t1}$	-	-	-	-	-

## Research highlights

### Centre for Soft Ground Engineering (CSGE), National University of Singapore (NUS) (Con't)

Soil parameters:

LL: liquid limit; PL: plastic limit; PI: plasticity index; LI: liquidity index;  $w_n$ : natural water content;  $s_u$ : undrained shear strength;  $s_u^{re}$ : remolded  $s_u$ ;  $\sigma'_p$ : preconsolidation stress;  $\sigma'_v$ : vertical effective stress;  $\sigma_v$ : vertical total stress; OCR: overconsolidation ratio;  $q_t$ : corrected cone tip resistance;  $u_2$ : pore pressure behind the cone;  $u_0$ : static pore pressure;  $B_q$ : CPTU pore pressure parameter;  $P_a$ : one atmosphere pressure;  $S_t$ : sensitivity;  $N_{60}$ : SPT N (corrected for energy ratio);  $D_r$ : relative density;  $\phi'$ : effective friction angle;  $(N_1)_{60}$ : SPT N (corrected for energy ratio & normalized by overburden stress);  $q_{t1}$ : normalized  $q_t$  (normalized by overburden stress).

#### References:

- Ching, J., Phoon, K. K. and Chen, Y. C. (2010). Reducing shear strength uncertainties in clays by multivariate correlations. *Canadian Geotechnical Journal*, 47(1), 16-33.
- Ching, J. and Phoon, K. K. (2012). Modeling parameters of structured clays as a multivariate normal distribution. *Canadian Geotechnical Journal*, 49(5), 522-545.
- Ching, J., Chen, J. R., Yeh, J. Y. and Phoon, K. K. (2012). Updating uncertainties in friction angles of clean sands. *ASCE Journal of Geotechnical and Geoenvironmental Engineering*, 138(2), 217-229.
- Ching, J. and Phoon, K. K. (2013). Multivariate distribution for undrained shear strengths under various test procedures. *Canadian Geotechnical Journal*, 50(9), 907-923.
- Ching, J. and Phoon, K. K. (2014). Transformations and correlations among some clay parameters - the global database. *Canadian Geotechnical Journal*, 51(6), 663-685.
- Ching, J., Phoon, K. K., and Chen, C. H. (2014). Modeling CPTU parameters of clays as a multivariate normal distribution. *Canadian Geotechnical Journal*, 51(1), 77-91.
- D'Ignazio, M., Phoon, K. K., Tan, S. A. & Lämsivaara, T. T. (2016). Correlations for undrained shear strength of Finnish soft clays, *Canadian Geotechnical Journal*, in press.

2. General Principles on Reliability for Structures (ISO2394:2015). From a geotechnical perspective, the key departure of the current ISO2394:2015 from previous versions is the introduction of a new informative Annex D on "Reliability of Geotechnical Structures". The need to achieve consistency between geotechnical and structural reliability-based design is explicitly recognized for the first time in ISO2394 with the inclusion of Annex D. Hence, the publication of Annex D of ISO2394:2015 on "Reliability of Geotechnical Structures" marks a major milestone in the advancement of geotechnical RBD. Annex D is the first guideline that attempts to identify features in geotechnical reliability that are distinctive from structural reliability. In particular, existing simplified RBD formats such as the Load and Resistance Factor Design (LRFD) do not allow room for the geotechnical engineer to exercise judgment in response to local site conditions and to incorporate local experience. Site-specific issues are however critical to geotechnical practice.

The ISO2394 revision secretariat consisting of Michael Havbro Faber (Convenor), Kazuyoshi Nishijima (Secretary), and Johan Retief is credited for the initiative to draft Annex D. The ISO2394:2015 Annex D drafting group consisting of Jianye Ching, Mahongo Dithinde, Kok-Kwang Phoon (Chair), Johan Retief, Timo Schweckendiek, Yu Wang, and Limin Zhang. The interested reader may refer to the following key publications:

- Phoon, K. K. & Retief, J. V. (Eds.) (2016). *Reliability of Geotechnical Structures in ISO2394*, CRC Press/Balkema.
- Phoon, K. K., Retief, J. V., Ching, J., Dithinde, M., Schweckendiek, T., Wang, Y. & Zhang, L. M. (2016). Some Observations on ISO2394:2015 Annex D (Reliability of Geotechnical Structures), *Structural Safety*, 62, 24-33.

## Research highlights

### Centre for Soft Ground Engineering (CSGE), National University of Singapore (NUS) (Con't)

Chun-Fai Leung and Yean-Khow chow

Performance of foundations due to soil movement

Dr C F Leung is a professor in the Department of Civil and Environmental Engineering, NUS. His research interests include soil-structure interaction, offshore geotechnics, and centrifuge modeling. Prof Leung currently serves on the editorial board of Geotechnique, OAME Journal, ISOPE Journal and other journals. He is a technical committee member of the ISO mobile jackup rig foundation panel and Singapore's national civil and geotechnical works standards. Prof Leung has served as Chairman of ISSMGE Geotechnical Physical Modeling and currently sits on the ISSMGE Offshore Geotechnics Technical Committee.



Professor Y K Chow is with the Department of Civil & Environmental Engineering, National University of Singapore (NUS). His research interests include offshore geotechnics, computational geomechanics, and soil-structure interaction. Professor Chow is the Executive Director, Maritime Institute @ NUS, Executive Director, Centre for Offshore Research & Engineering (CORE) and Director, Keppel-NUS Corporate Laboratory. He is on the Editorial Board of Computers and Geotechnics, International Journal of Geomechanics, Geomechanics and Geoengineering, and Geomechanics & Engineering. He is a Professional Engineer (Civil) and a Specialist Professional Engineer (Geotechnical Engineering) in Singapore.



Similar to many urban areas in the world, slope and deep excavations as well as tunneling are often carried out close to existing buildings. The large soil movements due to the above construction activities may induce severe stresses on the adjacent foundations supporting buildings and infrastructure nearby. Research studies have been carried out at NUS to investigate the above problems using centrifuge and numerical modeling.

The thick deposits of soft clay in many parts of Singapore are still consolidating and the large soil settlement would cause downdrag of the piles. As a pile would carry at least the structural dead loads of the structure, the centrifuge model study reveals that the magnitude of downdrag on the pile under such scenario would reduce as the pile has to settle under the loading. Tests on instrumented pile groups illustrate that the corner piles would experience the largest dragload while the center piles experience the least dragload, as shown in Figure 1. The deployment of pile group is beneficial against downdrag as that the average dragload per pile would decrease with increasing number of piles in a group. The mechanism of the load transfer of the pile-pile cap-soil interaction is further delved using numerical back analyses on the test results. It is found that the presence of rigid pile cap would moderate the load distribution of pile and as a result additional bending moments are induced on the pile cap and the pile tops due to interaction. The magnitude of reduction for a free head pile group and a capped head pile group is found to be of similar magnitude but with different pile load distribution.

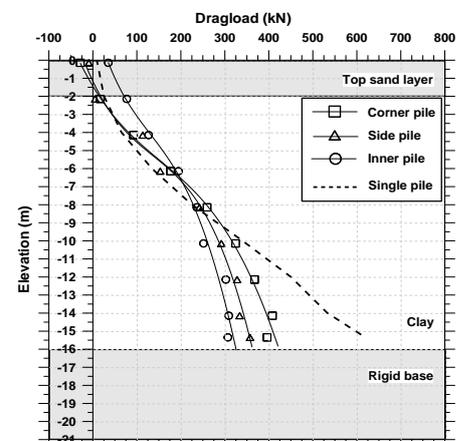


Figure 1 Distribution of loads among piles in a 16-pile group

**Research highlights**

**Centre for Soft Ground Engineering (CSGE), National University of Singapore (NUS) (Con't)**

Deep excavations are often carried out for the construction of deep basements for high-rise buildings in many parts of the world. Centrifuge model studies on the behavior of pile group subjected to excavation induced soil movement in sand and clay reveal that existing theories using the active pile approach would over-predict the pile bending moments and deflections. Under large free field lateral soil movements, the sand would flow pass the pile while the clay would induce less stress on the pile due to development of tension cracks. Coupled with numerical back analyses, the limiting pressures acting on a pile in sand and clay respectively have been developed and the pile performance can hence be more accurately predicted. The deployment of pile groups is again beneficial as the impact of lateral soil movement is reduced due to shielding of front piles over the rear piles. The findings from the research have been successfully applied to back analyze a case history of damage of bored piles due to slope excavation induced soil movements. Using the theoretical model developed from this research, the degree of structural damage of the bored piles at different stages has been identified, as illustrated in Figure 2.

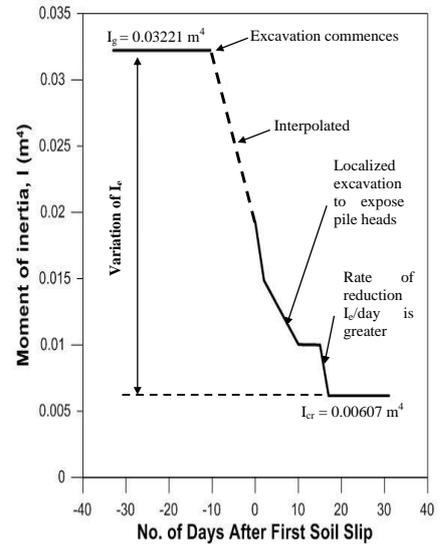


Figure 2. Damage of bored piles during different stages of soil movements (Ong et al., 2015)

Centrifuge and numerical model studies are ongoing to investigate the behavior of deep and shallow foundations adjacent to and beneath tunnel excavation. Compared to green field soil movements due to tunnelling, the foundation distortion is not as severe due to foundation rigidity. The distortion of buildings supported on foundations with various degrees of rigidity is being examined. The research findings reveal that regardless of centroid of the building load in relation to its foundation, the foundation response can be unified using the building plan dimension parameters. It is planned that the findings from the centrifuge and numerical studies will be evaluated against actual case studies of building and foundation due to tunneling in Singapore.

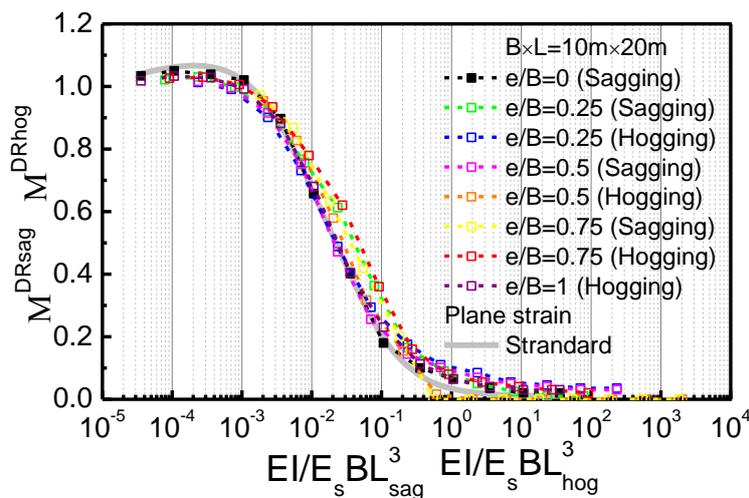


Figure 3. Unified foundation responses for building with different eccentricities

## Research highlights

### Centre for Soft Ground Engineering (CSGE), National University of Singapore (NUS) (Con't)

#### Kwet-Yew Yong

Professor Kwet-Yew Yong is Professor of Civil Engineering and Vice President (Campus Infrastructure) at the National University of Singapore which oversees the planning and sustainable development of campus infrastructure including the completed S\$1 billion University Town, one of the largest construction program undertaken in NUS. He has held senior positions including Head of Civil Engineering, Founding Director of Centre for Soft Ground Engineering, Chairman of NUS-MINDEF Centre for Protective Technology and Co-Chairman of NUS-MINDEF Infrastructure Committee.



Prof Yong's research is a microcosm of the infrastructure development in Singapore. In the early 1980s during the tall buildings boom, his research was on performance of pile foundation. Some of the findings were later incorporated into the Singapore Code for Pile Design. In the late 1980s, his research with several colleagues on land reclamation led to an award winning layered clay-sand scheme of reclamation using marine clay as an alternative to sand-only fill for reclamation. In the 1990s, several innovative methods of ground improvement including dynamic replacement and mixing, and inverted jet-grouted arch were developed to control movements associated with deep excavations and flood alleviation projects in urbanized Singapore and used widely in several reclamation and infrastructure projects in Indonesia and Malaysia. In the 2000s, with the rapid development of underground transportation, the focus was in the effects of tunneling on nearby buildings. The research group developed capabilities in 3D analyses of underground construction using GeoFEA and Plaxis programs that were used to predict performance of tunnelling through challenging ground and site conditions including mixed face tunnelling in a number of MRT projects. In the 2010s, the optimal use of land and underground space ranks high on the national agenda. Prof Yong is Co-Chair and Scientific lead in the Ministry of National Development (MND)/National Research Foundation (NRF) National Innovation Challenge on Land & Livability that looks into space creation and optimization in land scarce Singapore. He has published more than 200 technical publications, delivered over 30 keynote/guest lectures at international conferences.

Prof Yong is past Chairman of the Association of Geotechnical Societies in Southeast Asia and Past President of Southeast Asia Geotechnical Society. He also chairs/chaired several boards and national committees in land transport and construction including the International Board of Advisers to Land Transport Authority, Advisory Committee on Occupational Safety & Health for the Construction Industry (MOM), the Accredited Checkers Selection Panel (BCA) and MINDEF Supervisory Board for Land & Estates. He is a member of a high-level Development Projects Advisory Panel that vets and review large and complex public projects for the Ministry of Finance. He also serves on the Board/Exco of Land Transport Authority and chaired LTA's Independent Investigation Panel on Nicoll Highway Collapse in 2004 and was a member of the Expert Panel on Enhancing Flood Protection in Singapore, Ministry of Environment Water Resources (MEWR) in 2011/12. He received commendations from the Ministry of Manpower in 2000 and Ministry of Education in 2006, and 3 National Day Awards - Public Administration Medal (Silver) in 2000, Public Service Medal in 2004 and the Public Service Star in 2008 - for significant contributions to the university, construction safety and land transport respectively.

## Research highlights

### Centre for Soft Ground Engineering (CSGE), National University of Singapore (NUS) (Con't)

#### Harry Siew-Ann Tan

Harry Tan graduated in Civil Engineering from Auckland University in 1977, and did his MEng in Geotechnical Engineering in NUS in 1980, and MSc and PhD degrees in Geotechnical Engineering in UC Berkeley, California in 1981 and 1985, respectively. He has been on the faculty of NUS since 1980.

He has published over 200 technical papers covering topics such as Deep Excavations, Pile Foundations, Geosynthetics, Ground Improvement of Soft Clays, and Land Reclamation. He serves on the editorial board of “Geotextiles and Geomembranes”, of the International Society of Geosynthetics, and the Journal of “Geotechnical Engineering” of the South East Asian Geotechnical Society since 1997. He has served as a committee member of several technical committees, including the US Transportation Research Board committee A2K06 on subsurface drainage in highway pavements, TC-09 Technical Committee on Earth Reinforcement for the International Society of Soil Mechanics and Geotechnical Engineering, SPRING Singapore technical assessor on geotechnical testing and site investigation, Singapore SPRING committee on earthworks and geotechnical engineering. Prof Tan had served as Chairman of TR26 the new Technical Reference for Deep Excavation Works from 2005 to 2010. This code is the latest and current code for deep excavation in soft clays in Singapore.



He serves on the International Scientific Network committee for the Plaxis BV (Netherlands) code development, training and applications since 2002. He was actively involved as course leader and instructor in teaching Computational Geotechnics with Plaxis Asia for industry in the Asia-Pacific region since 2000. He has taught the use of Plaxis in Singapore, Malaysia, Korea, India, Australia and the Netherlands over the last 20 years.

He is a registered professional engineer in Singapore since 1992, and specialist geotechnical engineer since 2006, and has been involved in several major consulting jobs in Singapore and Malaysia. He was the leader of the State “Expert Witness Team” comprising of four international experts in the COI (Committee of Inquiry) for the Nicoll Highway LTA C824 cut/cover tunnel collapse incident of 20<sup>th</sup> April 2004. He also served as the State Expert Witness for the Church Street pile foundation failure case.

He was actively involved in many deep excavation and other geotechnical projects in both public sector and private sector cases: including many LTA projects in Circle Line, MCE, DTL1 and DTL2 stations and tunnels. He was an invited speaker at ER2010 (Earth Retention Conference at Seattle USA) for the session on case histories to address the subject of pitfalls in numerical analysis of retention systems for deep excavation.

## Research highlights

### Centre for Soft Ground Engineering (CSGE), National University of Singapore (NUS) (Con't)

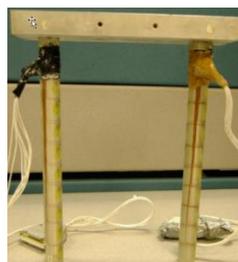
#### Siang Huat Goh

Siang Huat Goh is an Associate Professor in Geotechnical Engineering and the Deputy Director of the Centre for Protective Technology. He has a strong interest in soil dynamics, and has carried out research on characterizing and modeling the response of sands and clays under dynamic loadings, such as those caused by earthquakes and buried explosions. He has also looked into various problems involving dynamic soil-structure interaction. His work covers both experimental testing (centrifuge modeling and full-scale field trials) and advanced numerical simulations of wave propagation in dry and saturated soils.



Siang Huat was the principal investigator of a project that examined the potential for blast-induced liquefaction in reclaimed sand deposits. Centrifuge tests were performed which successfully captured both the initial high-pressure blast pulse propagating through the saturated soil and the subsequent build-up and dissipation of the residual pore pressure associated with the liquefaction process. Also arising from this project was the development of an overlapping mesh method for performing fully-coupled dynamic finite element analyses in saturated porous media, which can be readily implemented on commercial software platforms such as ABAQUS. Currently, he is involved in a follow-up project to study the effects of impact and shock loading on buried pipelines.

The effect of soft ground amplification on single piles and pile groups due to far-field seismic ground motion excitation is another area of study for Siang Huat. Both centrifuge experiments and 3-D finite element analyses have been performed, the results of which were used to derive simplified correlations for estimating the pile bending moments and the raft accelerations. As part of this study, a PC network cluster was also set up to perform highly parallelized 3D FE computations of large scale dynamic soil-structure interaction problems involving several millions degrees of freedom.



2-Pile



Partially completed centrifuge blast test model during sensor placements



12-Pile



Partially completed model with instrumented pipe

Centrifuge Model Setup with Laminar Box Containing Soft Clay and Embedded Pile Group System

## Research highlights

### Centre for Soft Ground Engineering (CSGE), National University of Singapore (NUS) (Con't)

#### Soon-Hoe Chew

Dr. Soon-Hoe Chew, a Professional Engineer, graduated with a PhD from the University of California at Berkeley, USA, after completing a Research Project on Geosynthetics Reinforced Soil Walls. He is currently an Assistant Professor with the Department of Civil and Environmental Engineering, National University of Singapore. His past administrative roles include Assistant Dean of the Faculty of Engineering, and the Deputy Director of the Centre for Protective Technology (CPT), a research and development centre jointly formed by the Ministry of Defence, Singapore, and NUS. He was elected to be a council member of the Institution of Engineers, Singapore, IES 2006-2011, as was re-elected for 2011-2015 and 2016-2018. He is also currently the President of Southeast Asia chapter of International Geosynthetics Society (IGS), and a Council member of Singapore Chapter of American Society of Civil Engineers (ASCE).



His main research interests include geosynthetics, slope engineering, land reclamation, soil improvement, deep excavation in soft soils, numerical modeling in geotechnical engineering, geo-environmental engineering and geological engineering. Dr Chew published extensively on soft clay and ground improvement related topics. He was awarded “Defence Technology Prize” from Chief Defence Scientist, Ministry of Defence, Singapore in 2006. He was also the recipient of the “Minister Innovative Awards” from Ministry of Transportation, 2011, on his “innovative use of geotube filled with cement mixed soft clay”. He was also awarded with “Friends of Waters” by PUB, the water agency in 2013. His latest award is “2015 Minister’s Awards (Team)” by the Ministry of National Development on the project supporting the HDB team of engineers on “Reuse of soft clay for infilling works at Pulau Tekong”, awarded on National Day Celebration 2015.

Dr Soon-Hoe Chew’s main research interest in the last 10 years is on geosynthetics, geo-environment study and soil improvement. With the shortage of sand for reclamation works in Singapore, and the innovative use of excavated soil as the infilling materials for reclamation purposes, his research efforts are currently directed towards geotextile containment for offshore disposal and reclamation, cement-polymer-soil treatment for this soft fill, use of electric PVD, vacuum consolidation and Special Well Point technique for in-situ treatment during dumping of these soft fill.

The following give a quick summary of some of his latest research thrusts:

1. Geotextile Tube for dewatering application. Geotextile tube gains popularity in the sludge dewatering industry since last decade because of its cost effectiveness in encapsulating a large amount of solid particles while discharging the relatively clean supernatant water. The main mechanism is the effective filter cake formation at the geotextile skin. Several laboratory-scale dewatering tests have been developed (by PhD students Mr Eng Zi Xun and others) to evaluate the dewatering performance of the geotextile tube with respect to the type of selected flocculent or coagulant, soft soil fill characteristic, and geotextile type. Test method takes into account the nature of flow dynamic in the filling action which highly affects the filter cake formation. An analytical method was developed for this. A series of large-scale dewatering test was successfully performed, and the results obtained verified the proposed analytical method.

Research highlights

Centre for Soft Ground Engineering (CSGE), National University of Singapore (NUS) (Con't)

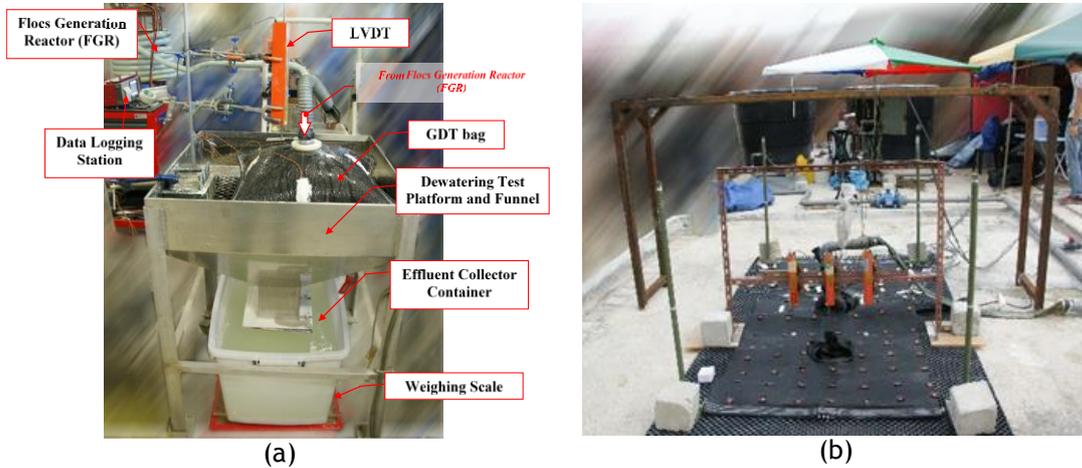


Figure 1. Dewatering performance test: (a) Modified Geotube Dewatering Test (M-GDT); (b) Large-scale Outdoor Dewatering Test

2. Geotextile Tube for reclamation application. Geotextile tube can be used as a containment system to encapsulate the dredged materials for offshore disposal or reclamation purposes. It was filled in a split-bottom barge. In view of the harsh condition at the filling and dumping stages in offshore environment, the strength requirement of the geotextile to withstand the high tensile forces is critical. With this, a 3-D large scale testing apparatus was developed to test the seam strength of the inlet port. A number of field studies for instrumented geotextile tubes used as the offshore dumping unit were successfully conducted in Singapore and Hong Kong (assisted by PhD student Tan Czha Yheaw and others). These research works involved the installation of specially designed sensors and was monitored during the filling and dumping stage of geotextile tube. The monitoring results are very helpful in evaluating the safety margin of the operation with geotextile tube as an offshore dumping unit.

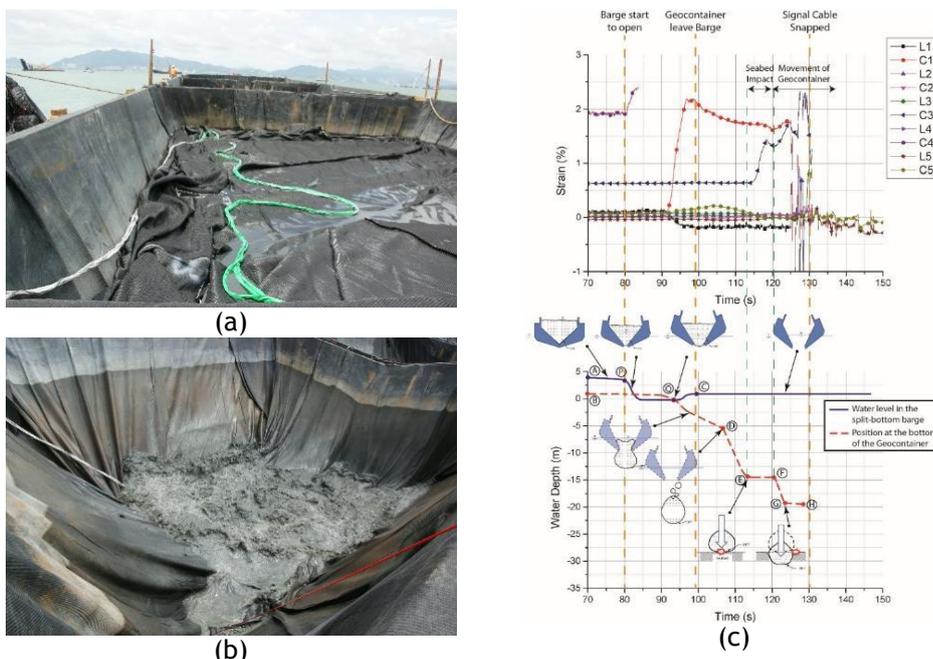


Figure 2. A field study of a geotextile tube used as offshore dumping unit in Hong Kong

## Research highlights

Centre for Soft Ground Engineering (CSGE), National University of Singapore (NUS) (Con't)



Figure 3. The field study of geotextile tube used to construct the undersea containment bund in Singapore: (a) Filling of geotextile tube in split-bottom barge; (b) Dropping of geotextile tube into seabed; (c) Completion of the undersea containment bund with geotextile tubes

- Ground improvement techniques and its integration study for reclamation with soft clay fill. As part of a holistic approach for increasing the land reclamation fill volume during the dumping stage, the use of vacuum consolidation with vertical and horizontal drains, and special well point concept are studied. These ground improvement techniques are integrated with each other, and coupled with the bearing capping top layer. One of the key features of this rapidly created top layer is high bearing capacity with low permeability. This high bearing capacity allows for early site access to perform various ground improvement works. The effective method of mixing and optimum mix ratio for cement-polymer-soil admixtures are developed. PVDs with vacuum consolidation is studied, together with the use of the low permeability top layer to eliminate the use of membrane for vacuum consolidation. In addition, the conventional PVDs with vacuum consolidation, the use of Special Well Point concept for consolidation is also being delved into. A number of full-scale pilot trials would be carried out at existing land reclamation sites to evaluate the feasibility of using all the above ground improvement techniques and the integration between them on a large scale basis.

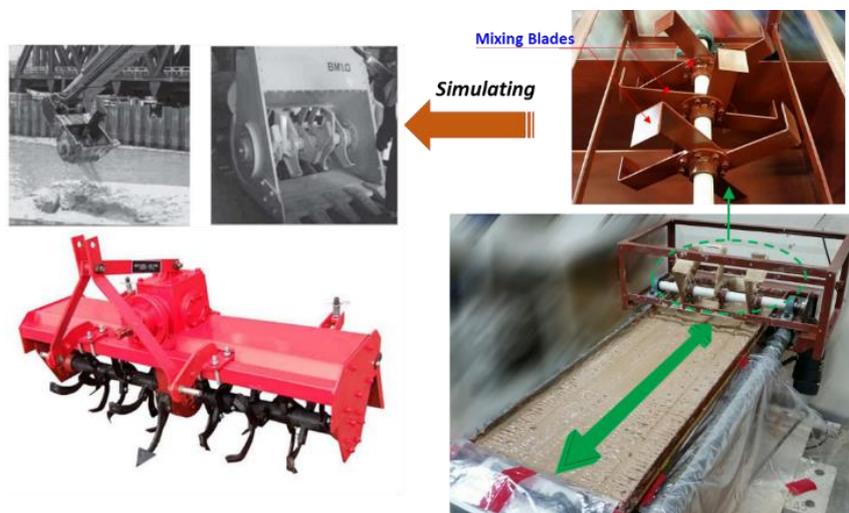


Figure 4. A "Shallow Mixing Machine" developed for cement-polymer-soil in NUS Geotechnical Laboratory

## Research highlights

### Centre for Soft Ground Engineering (CSGE), National University of Singapore (NUS) (Con't)

#### Siau Chen CHIAN (Darren)

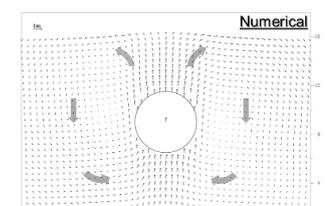
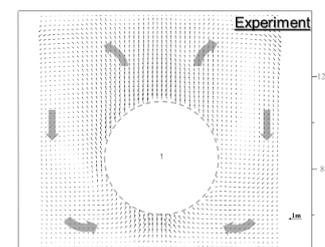
Dr. Darren Chian is an Assistant Professor in the Department of Civil and Environmental Engineering at the National University of Singapore (NUS) and the Operations Manager of the MINDEF-NUS Centre for Protective Technology. He is also the vice-president of the Geotechnical Society of Singapore (GeoSS), and a nominated member for several ISSMGE technical committees, namely, TC104 Physical Modelling in Geotechnics, TC203 Earthquake Geotechnical Engineering, and TC217 Land Reclamation. Dr. Chian obtained his Ph.D. and B.Eng. with Gold Medal from Cambridge University and Nanyang Technological University (NTU) respectively.



Building collapse, 2009 Padang Earthquake, Indonesia (EEFIT, 2009)

In the area of earthquake geotechnical engineering, Dr. Chian was the geotechnical-specialist in post-earthquake missions to the Mw7.6 Padang Earthquake in 2009 and the Mw9.0 Tohoku Earthquake in 2011 with the UK Earthquake Engineering Field Investigation Team (EEFIT), under the auspices of the Institution of Structural Engineers (IStructE), London. His research has succeeded in capturing the phenomenon of uplift damage of underground structures in details that has not been observed before with the use of a high-speed camera. The novelty is the analysis with Particle Image Velocimetry (PIV) technique, particularly in liquefied soil, supported with miniature sensors to measure the conditions of the soil surrounding the tunnel. His research confirms that the transient softening of the soil due to seismic shaking permits the lighter tunnel to displace upward, however the

pressure induced by the uplifting tunnel also regains the overlying soil's strength which inhibited continual uplift. Hence, uplift ceases as soon as the earthquake shaking ends. This important research finding has corrected and shed new light on the long-standing hypothesis that the uplift phenomenon is merely an Archimedes principle of buoyancy which persists past the earthquake duration. Presently, his research is extended to manholes which are more susceptible to uplift than pipelines and has greater impact to urban society as evident in the recent 2011 & 2012 Christchurch Earthquakes, 2011 Tohoku Earthquake, and 2010 Chile Earthquake. Several remediation techniques have been devised following an extensive suite of centrifuge modelling tests. In addition, studies on non-uniform cyclic testing of liquefiable soils is also on-going with attempt to represent the irregularity of earthquake loading in the field better. Although larger shear strain amplitude tends to generate high excess pore pressures as commonly observed in uniform cyclic tests, they produce lower excess pore pressures in non-uniform cyclic tests due to greater tendency of dilation.



Experimental (PIV) and numerical (FLAC) analysis of uplift of circular underground structures (Chian, Tokimatsu & Madabhushi, 2014), ASCE JGGE

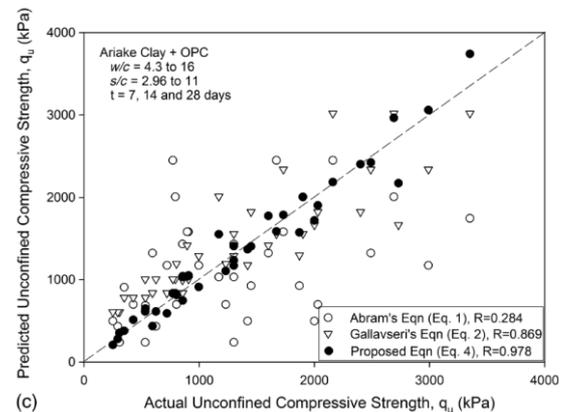
In the area of land reclamation, Dr. Chian has carried out an extensive suite of laboratory tests of cement treated clays as a means of converting unwanted soils from underground construction and sea dredging to useful reclamation fill materials. Three significant milestones have been achieved: 1) an improved predictive strength development model was developed which considers the effect of soil-water-cement mix proportions and curing duration. The model was demonstrated to be superior to existing classic prediction models used in the industry, and applicable to several clays and cement types with good fit to experimental data indicated by correlation coefficients exceeding 0.95, 2) the introduction of the free-water:cement ratio,  $(w/wL)/c$ , in order to account for the variation in microfabric characteristics

## Research highlights

### Centre for Soft Ground Engineering (CSGE), National University of Singapore (NUS) (Con't)

and pore spaces induced by sand, which was proven to be more appropriate in assessing strength development of cement-treated soils than conventional water:cement ratio ( $w/c$ ), 3) the introduction of the several correlations between early- and later-age strength and the use of portable bender element devices to identify potential defective mixes for quality control in construction as early as within 3 days for timely remedial actions.

Dr. Chian's expertise in the area of earthquake engineering and land reclamation has led to the invitation to speak in several international and regional conferences and meetings. He also advises the Disaster Assistance and Rescue Team (DART) of the Singapore Civil Defence Force on building and geotechnical safety during overseas earthquake search and rescue missions. Dr. Chian is the awardee of Asia's Top 10 Innovators under 35 years by MIT Technology Review in 2015, 1<sup>st</sup> Prize in the National Technical Paper Competition in 2013, and Best Young Researcher Award at the 8<sup>th</sup> International Conference on Urban Earthquake Engineering in 2011.



Strength prediction of cement treated Ariake clay with OPC at different water:cement, soil:cement ratios and curing ages (Chian, Nguyen & Phoon, 2015), ASCE JGGE

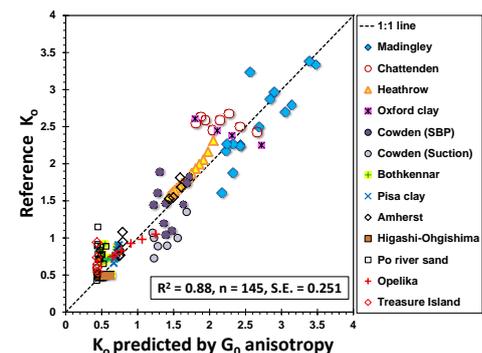
### Taeseo Ku

Dr. Taeseo Ku is an Assistant Professor in the Department of Civil and Environmental Engineering at the National University of Singapore. Dr Ku joined the NUS in 2013 after some research experiences (graduate assistant, post-doc and senior researcher) in the United States and Korea. He obtained his Ph.D. from Georgia Institute of Technology (GT in-situ testing group in GeoSystems Division), M.S. in GeoEngineering from University of California-Berkeley, and B.S. from Yonsei University, Korea. He is currently a nominated member for TC 101 (Laboratory Stress Strength Testing of Geomaterials) and TC 102 (Ground Property Characterization from In-Situ Tests), ISSMGE.



Dr Ku's research interests are on the related areas of in-situ geotechnics and geophysical site investigations. He has attempted to develop consistent, rational, and practical unified geotechnical interpretation frameworks for evaluating soil parameters based on both in-situ, geophysical, and laboratory tests. For instance, a focused area centers on the measurement, evaluation, and application of elastic waves (e.g., shear wave velocity ( $V_s$ ) and the related small-strain stiffness ( $G_0$ ) in soils), with particular interests related to geotechnical site characterization. In terms of the advanced seismic wave-based geo-characterization, some recent applications and/or current research projects are introduced.

1. Geostatic Stress State Evaluation by Paired Directional Shear Waves. His recent research concerned the evaluation of geostatic stress state and stress history by use of directional shear wave velocities. He developed statistical algorithms for assessing stress history and geostatic stress conditions (e.g., lateral earth pressure) based on paired complementary sets of directional shear wave modes from a special elite worldwide database that was compiled for this purpose. The observed degree of in-situ  $V_S$  or  $G_0$  anisotropy can provide the ideal opportunity.

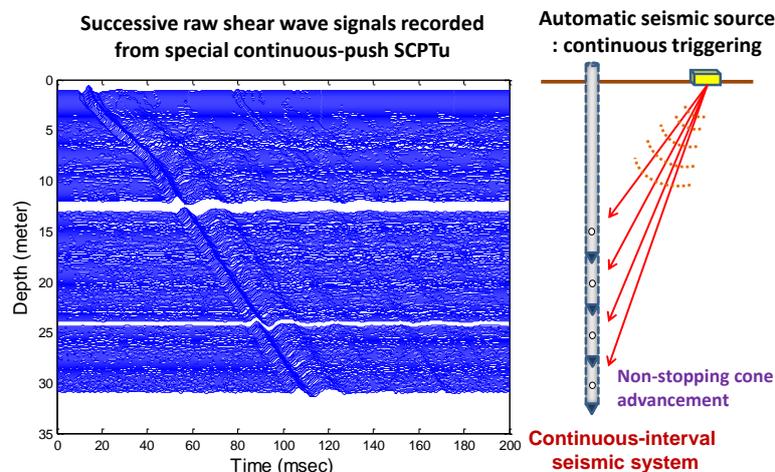


(figure from Ku and Mayne 2015)

## Research highlights

### Centre for Soft Ground Engineering (CSGE), National University of Singapore (NUS) (Con't)

2. Continuous-interval VS Profiling by Auto-Source and Seismic Piezocone Tests. Dr Ku's another contribution involves the development of reliable and automated evaluation techniques for continuous shear wave velocity measurements taken during seismic cone penetrometer testing. A new exploratory procedure for collecting continuous VS measurements via cone penetration testing using a special autoseis source is presented whereby wavelets can be generated and recorded every 1 to 10 s. The continuous-interval seismic piezocone test offers a fast, productive, and reliable means to expedite the collection of downhole VS profiles, as well as additional readings on cone tip resistance, sleeve friction, and penetration porewater pressures with depth.



(figure from Ku et al. 2013)

3. Non-invasive Geophysical Study for Bedrock Evaluation. This is an ongoing project supported by The Singapore Land Transport Authority. The goal of this research is to examine and establish technically and economically preferable non-invasive seismic wave-based methods (e.g., surface wave, reflection/refraction) for underground bedrock detection, with consideration of degree of rock weathering which is commonly observed in tropical regions like Singapore. This study is expected to provide critical scientific/ experimental observations on characteristics of surface wave propagation in Singapore's geologic context with various rock mass conditions.
4.  $V_s$ -based Global Correlation Study for Evaluating Soil Properties: He has also focused on comprehensive geocharacterizations with both analytical geotechnical solutions and empirical approaches based on advanced data analysis techniques. For instance, some recent researches include shear wave velocity based estimation of soil unit weight and undrained shear strength via a special database compiled from well-documented geotechnical test sites. Stress-dependent and anisotropic characteristics of  $V_s$  are considered.

## Offshore Geotechnics

(Inputs by Yean-Khow Chow, Chun-Fai Leung and Fook-Hou Lee)

Singapore shipyards fabricate about two-third of mobile jack-up rigs worldwide. At NUS, extensive centrifuge and numerical model studies had been carried out to investigate the behavior of jack-up spudcan foundation in relation to foundation punch through and extraction difficulties, interaction between spudcan and adjacent pile, and interaction between spudcan and existing footprints due to previous spudcan installation. Three Joint Industrial research projects (JIP) on the above topics have been completed.

## Research highlights

### Centre for Soft Ground Engineering (CSGE), National University of Singapore (NUS) (Con't)

For spudcan jack-up punch through hazard in sand over clay, the studies identify that conventional bearing capacity theories do not predict the punch through hazard correctly as a sand plug beneath the spudcan base is being formed during preloading. The centrifuge study summarized in Figure 1 reveals that the prediction of punch through distance is also critical, which is now referred to in the ISO 19905-1 2012 code. For spudcan extraction, it is established that the suction between the spudcan base and the clay develops with time and a large extraction force is required if the jack-rig remains longer at a site. The findings of the above research studies are now provided in the InSafe Guidelines on safe spudcan operation jointly conducted by NUS, Oxford University and University of Western Australia.

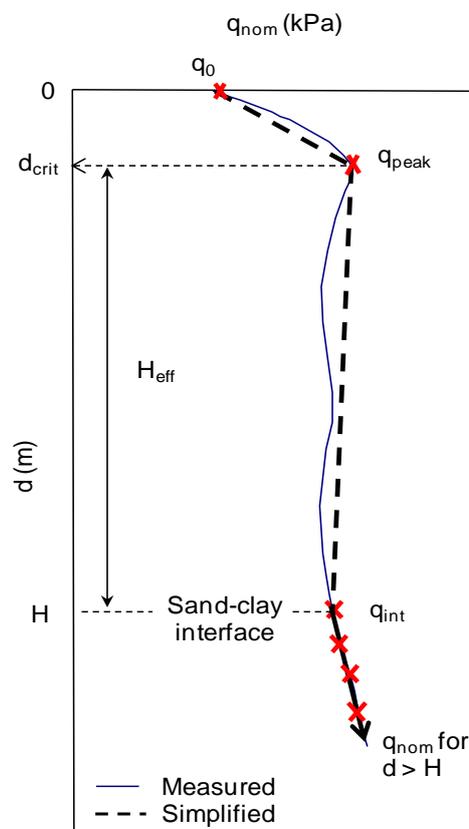


Figure 1. Identification of important parameters for spudcan punch through hazard in sand over clay (Teh et al. 2010 from *Géotechnique*)

For the study on the interaction between spudcan installation and the adjacent piled foundation supporting the permanent jacket platform, SNAME specifies that spudcan-pile interaction needs to be evaluated in detail if the clearance between the spudcan and pile is smaller than one spudcan diameter. Arising from the NUS research, design charts on induced pile moments between spudcan and pile in close proximity was presented at an earlier OTC conference in Houston. A JIP funded by 8 offshore engineering organizations on remediation measures of spudcan reinstallation in footprints has just been completed. The spudcan-footprint interaction characteristics and mechanism are now much better understood. If used strategically and systematically, stomping of footprints is established to be an effective method in alleviating the severe interaction without the danger of spudcan sliding into the footprint during reinstallation. Another aspect of spudcan study is the effect of lattice leg on soil flow, cavity formation and ultimately, on settlement and bearing capacity. The results of the study, which are currently in press, indicate that the main effect of the lattice leg is to deepen the cavity immediately after installation, Figure 2. The shape of the cavity is also different from that without lattice leg and is characterized by a

## Research highlights

Centre for Soft Ground Engineering (CSGE), National University of Singapore (NUS) (Con't)

section of steep-sided cavity wall that is co-planar with the lattice leg. This accentuates the likelihood of soil collapse into the cavity during operation, thereby increasing the possibility of large settlement. This can also potentially influence punch-through occurrence and measures to alleviate punch-through have been proposed.

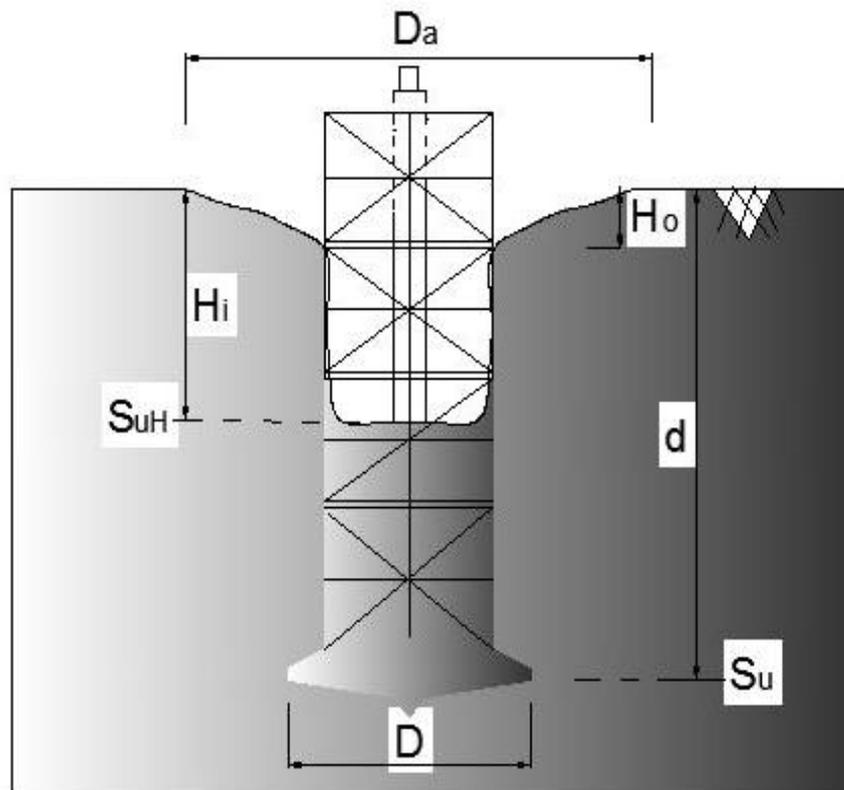


Figure 2. Typical cavity shape with lattice leg

Oil and gas explorations now advance into deep waters. Anchoring is a common foundation mean of securing floating platforms in open seas. Numerical and centrifuge model studies are carried out to examine the anchor performance in normally consolidated clay and in non-homogeneous clay. The DNV guidelines specify that the shear strength of the clay at the initial anchor elevation may be considered as the reference strength for design. The study at NUS shown in Figure 3 clearly establishes that the failure mechanism for anchor uplift in normally consolidated clay and clay with increasing strength profile are marked different. The dimensionless soil overburdening factors incorporating the soil strength profile are found to be appropriate in predicting the anchor uplift resistance in non-homogeneous clay. The study on long term capacity of plate anchors under sustained loadings is currently in progress. Study is also ongoing on dynamically installed anchors. This study encompasses the effects of soil states, fin shapes and pullout orientation. An important finding is that the fin shape has a very significant effect on the lateral capacity of the anchors.

## Research highlights

Centre for Soft Ground Engineering (CSGE), National University of Singapore (NUS) (Con't)

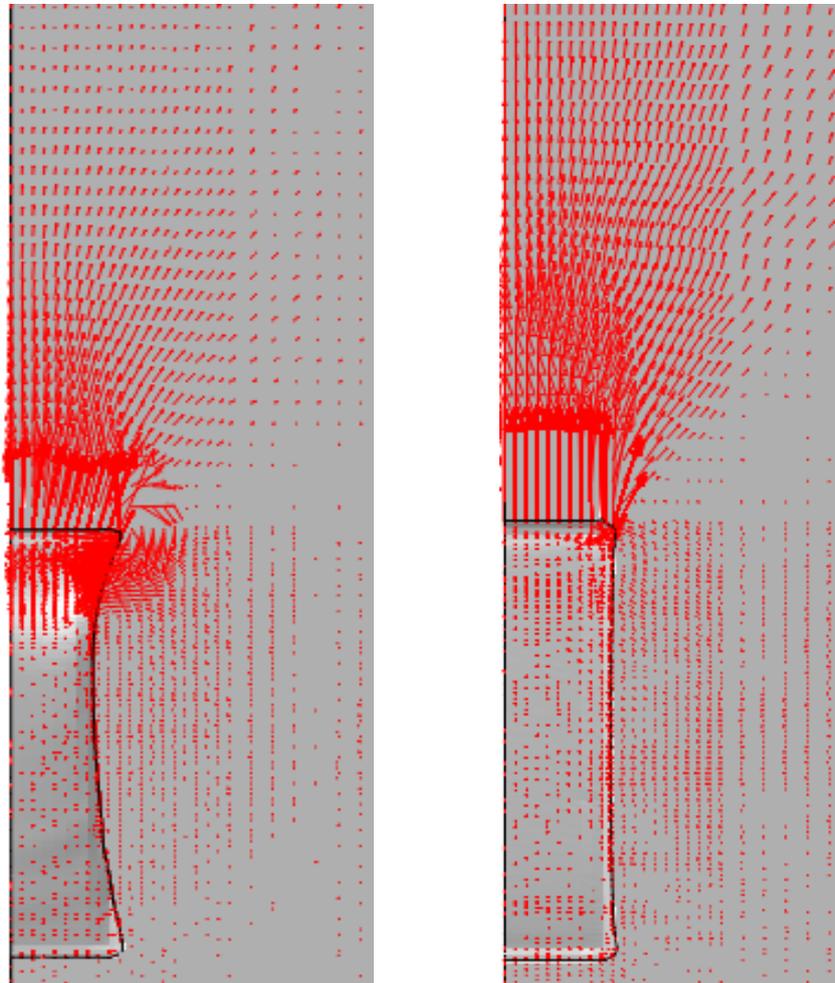


Figure 3. Differences in failure mechanisms for uplift resistance of plate anchors in (a) normally consolidated clay and (b) non-homogeneous clay (Tho et al. 2013 *Canadian Geotechnical Journal*)

Another deep water offshore geotechnics problem involves pipeline-soil interaction. Pipelines within the touch down zone of the seabed would be subjected to repeated vertical motion. The results of centrifuge tests reveal that the soil would be almost fully remolded after about 8 cycles of vertical pipeline motion. Figure 4 shows the differences in the load-displacement responses in normally consolidated clay and in overconsolidated clay having an overconsolidation ratio of 3. Back analyses of the test data reveal that the remolded shear strength obtained from ring shear tests can be used to predict the soil resistance in the long term. Ongoing research is being carried out to examine the behavior of pipelines having free span length without soil support. Centrifuge and numerical studies are being carried out to examine the behavior of the pipeline resting on the soil shoulder in the vicinity of free span. In addition, centrifuge model and numerical studies are also on-going to examine pipeline-soil interaction in “pipe-walking”, and how this may vary with displacement and time.

## Research highlights

Centre for Soft Ground Engineering (CSGE), National University of Singapore (NUS) (Con't)

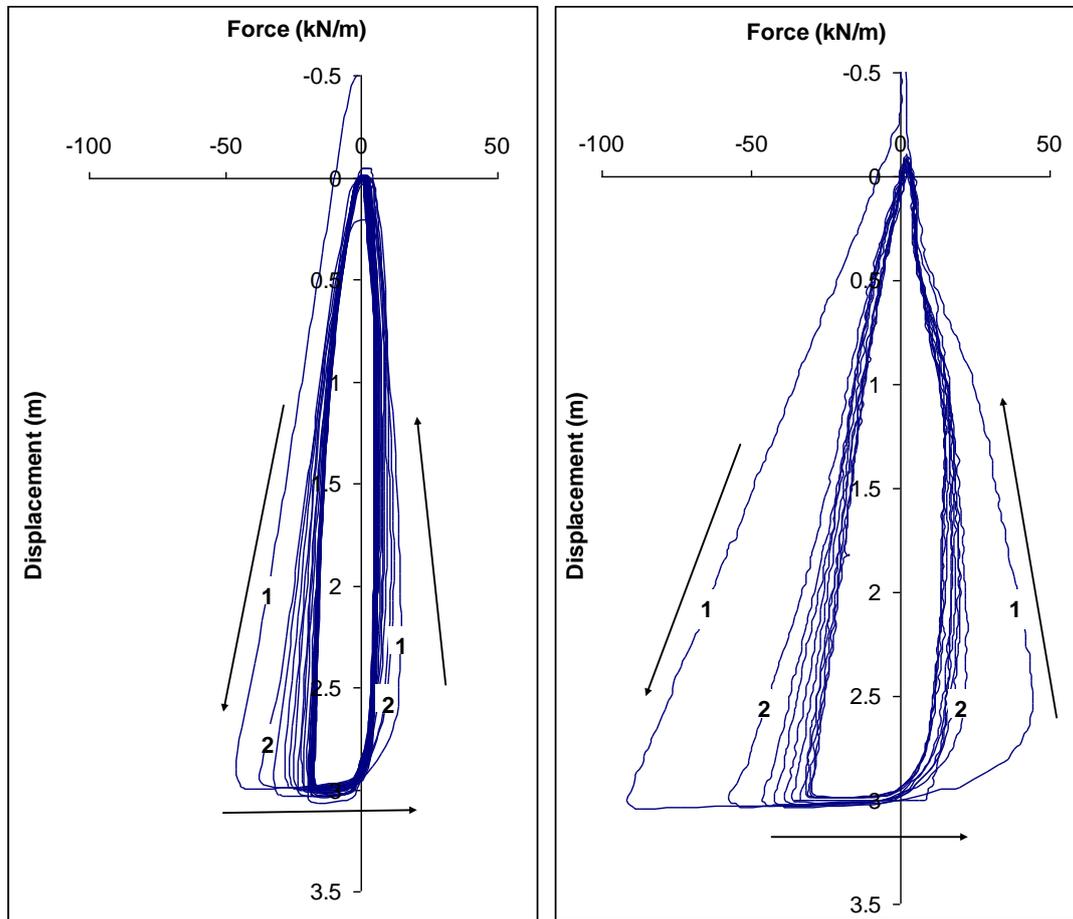


Figure 4. Load-displacement responses for repeated vertical motion of pipeline in (a) normally consolidated clay and (b) overconsolidated clay with OCR = 3 (Hu et al. 2011, Ocean Engineering)

Fook-Hou Lee  
Director, Centre for Soft Ground Engineering (CSGE), NUS

## Research highlights

### Geotechnical Studies at COPPE (Graduate School of Engineering) - UFRJ (Federal University of Rio de Janeiro), Brazil

Undergraduate engineering teaching initiated in Brazil in the XVIII century at the Polytechnic School of Engineering of Federal University of Rio de Janeiro (UFRJ). However, research in Civil Engineering started in the mid 1960s at COPPE (Graduate School of Engineering) and Jacques de Medina, Willy Lacerda and Dirceu Velloso created COPPE-UFRJ's Geotechnical Group in 1967. Since the 1970s the group has experienced increase in its teaching and research staff, counting today with the following active lecturers: Willy Lacerda, Anna Laura Nunes, Claudio Mahler, Fernando Danziger, Francisco Lopes, Ian Martins, Márcio Almeida, Mauricio Ehrlich, Laura Motta, Francisco Casanova, Maria Claudia Barbosa, and Thiago Aragão.

The research conducted in this area of concentration includes practically all activities related to Geotechnics in Civil Engineering, with laboratory and field investigation, as well as analytical and numerical studies. The main research topics are: earth works, environmental geotechnics, foundations and soil-structure interaction, in situ tests and instrumentation, pavements and soil stabilization, reinforced soils, slopes stability and earth retaining systems, soft soils, rheology of soils and rocks mechanics.

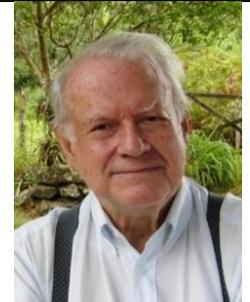
An important feature of the Geotechnical Concentration Area is its strong interaction with the industry. In this sense it has developed outreach activities in all subjects mentioned above, through research projects with both state-owned and private companies. Examples are: slope stabilization and retaining system for earth and rock slopes in urban areas and in highways; walls reinforced with geosynthetics (both laboratory/model and field studies); innovative construction solutions for embankments on very soft soils in urban areas, ports and roads; geotechnical investigations in the laboratory and in the field, including CPTu, DMT and vane tests (some equipments developed at COPPE); monitoring of geotechnical problems and civil works, such as slopes, retaining structures, embankments and foundations; consulting for special foundations; studies of pipelines and risers for the oil industry through centrifuge and numerical modeling; studies of unsaturated soils and erosion; laboratory studies for roads and railways; soil contamination studies; studies of wastes (municipal solid, dredging sediments and mining wastes); low-cost bricks made with stabilized soil; innovative techniques for covering waste fills; earth and rock fill dams. As a result, the research developed in these studies has had a direct impact on the geotechnical engineering practice in Brazil.

The Geotechnical Laboratory of COPPE occupies an area of about 2,000 m<sup>2</sup>, with the following sectors: soil characterization, strength and deformation testing of soils, pavements (including asphalt), chemistry and mineralogy of soils, physical modeling (drum and arm centrifuges, 1G models and calibration chamber), environmental geotechnics, rock mechanics, field testing and instrumentation.

## Research highlights

### Geotechnical Studies at COPPE (Graduate School of Engineering) - UFRJ (Federal University of Rio de Janeiro), Brazil (Con't)

#### Academic staff

			
<p><b>Anna Laura</b></p> <ol style="list-style-type: none"> <li>1) Rock mechanics</li> <li>2) Geosynthetics</li> <li>3) Tunneling</li> </ol>	<p><b>Cláudio Mahler</b></p> <ol style="list-style-type: none"> <li>1) Solid waste landfills</li> <li>2) Phytoremediation</li> <li>3) Composting</li> </ol>	<p><b>Fernando Danziger</b></p> <ol style="list-style-type: none"> <li>1) Foundations</li> <li>2) Instrumentation</li> <li>3) Site investigation</li> </ol>	<p><b>Francisco Casanova</b></p> <ol style="list-style-type: none"> <li>1) Soil Stabilization</li> <li>2) Low carbon and energy materials</li> <li>3) Wastes in construction</li> </ol>
			
<p><b>Francisco Lopes</b></p> <ol style="list-style-type: none"> <li>1) Foundations and excavations</li> <li>2) Numerical methods in Geomechanics</li> <li>3) Groundwater control</li> </ol>	<p><b>Ian Martins</b></p> <ol style="list-style-type: none"> <li>1) Soil sampling</li> <li>2) Stress-strain-strain rate relationships</li> <li>3) Soil testing</li> </ol>	<p><b>Laura Motta</b></p> <ol style="list-style-type: none"> <li>1) Pavement Mechanics</li> <li>2) Pavement Materials</li> <li>3) Design Methods</li> </ol>	<p><b>Márcio Almeida</b></p> <ol style="list-style-type: none"> <li>1) Earth works</li> <li>2) Soft clays</li> <li>3) Physical modeling</li> </ol>
			
<p><b>Maria Claudia</b></p> <ol style="list-style-type: none"> <li>1) Solid waste disposal</li> <li>2) Contaminant transport in soils</li> <li>3) Electrokinetics</li> </ol>	<p><b>Maurício Ehrlich</b></p> <ol style="list-style-type: none"> <li>1) Reinforced soil walls and soil nailing</li> <li>2) Landslides</li> <li>3) Clogging by ochre</li> </ol>	<p><b>Thiago Aragão</b></p> <ol style="list-style-type: none"> <li>1) Rheology of asphaltic materials</li> <li>2) Fracture mechanics</li> <li>3) Multiscale modeling</li> </ol>	<p><b>Willy Lacerda</b></p> <ol style="list-style-type: none"> <li>1) Landslides</li> <li>2) Residual soils</li> <li>3) Soft clays.</li> </ol>

## Research highlights

### Geotechnical Studies at COPPE (Graduate School of Engineering) - UFRJ (Federal University of Rio de Janeiro), Brazil (Con't)

#### Unsaturated Soils and the Environment

Claudio Fernando Mahler, [cfmahler@gmail.com](mailto:cfmahler@gmail.com)

Over the past two decades, the Group for Solid Waste Studies and Technology (GETRES) has developed various projects in the field of environmental geotechnics, encompassing recovery of degraded and contaminated areas and management and treatment of municipal wastes.

In this effort, techniques such as phytoremediation, composting and mechanical-biological treatment have been intensively studied. Composting has been studied to produce material to be incorporated as landfills covers to minimize greenhouse gas emissions by creating a capillary barrier effect to control the water access in landfills.

Phytoremediation has been employed to clean up soils contaminated with heavy metals and organochlorides (near highways and railways), as well as to treat leachate in wetlands located near sanitary landfills.

The use of the plant *Chrysopogon zizanioides*, popularly called vetiver grass, has been also a research target. The vetiver has been studied in relation to protect soils against erosion, increase the resistance of hillsides and embankments (due to its deep and extensive roots), besides remediation of contaminated areas. To better support and understand the gain in resistance from the presence of vetiver on slopes, triaxial compression and extension tests have been performed. Besides this, numerical models have also been developed and applied to decontamination processes.

Sanitary landfills have also been studied regarding their stability, construction processes, and acceleration of the process of degradation, lifetime, cover and liner impermeabilization. In this respect, a new device for continuous monitoring of the integrity of HDPE liners was developed. Finite element computer programs have often been used to analyze the water balance and flow through the cover of landfills, besides in situ monitoring.

#### Main Topics:

##### 1) Phytoremediation

- Studies of decontamination of areas contaminated by heavy metals and pesticides near highways, railways and in mining regions;
- Studies of treatment of leachate produced by municipal solid waste landfills; and
- Numerical modeling of processes

##### 2) Composting

- Development of equipment for single- and multi-family composting processes;
- Studies of reducing greenhouse gas emissions by composting;
- Study of the percentage ratio between organic and green wastes used to maximize and accelerate the composting process;
- Composting strategies, such as pretreatment of solid organic wastes;
- Study of the reduction of greenhouse gas emissions via composting; and
- Development of numerical models for the composting process

##### 3) Compost

- Study of the use of compost as landfill cover material, to minimize greenhouse gas emissions and as capillary barriers;
- Studies of the geotechnical parameters of compost and its mixture with other materials; and
- Studies of the fiber content of materials from composting and the mechanical-biological process

## Research highlights

### Geotechnical Studies at COPPE (Graduate School of Engineering) - UFRJ (Federal University of Rio de Janeiro), Brazil (Con't)

#### 4) Municipal solid wastes and landfills

- Evaluation, classification and disposal of wastes;
- Evaluation of cities in managing municipal solid wastes;
- Use of neural networks to predict the production and types of wastes;
- Study of health service waste (HSW) management;
- Analysis of municipal solid waste landfills (monitoring, stability, drainage systems and sustainability);
- Monitoring of HDPE liners through a continuous geoelectrical system developed at COPPE, employing numerical modeling;
- Utilization of wastes for the production of biofuel and H<sub>2</sub>;
- Studies of batteries and their negative effects on the environment;
- Study applying the life-cycle assessment (LCA) model for management of waste electrical and electronic equipment (WEEE);
- Treatment of leachate by special processes;
- Waste management and life-cycle assessment (LCA)



Figure 1. Health service waste management



Figure 2. Rotating bin composter



Figures 3 and 4. Composter and its compartments



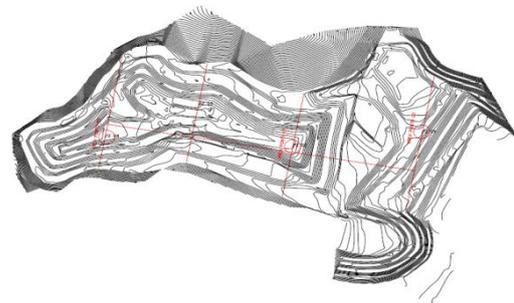
Figures 5 and 6. Development of a prototype single-family composter

**Research highlights**

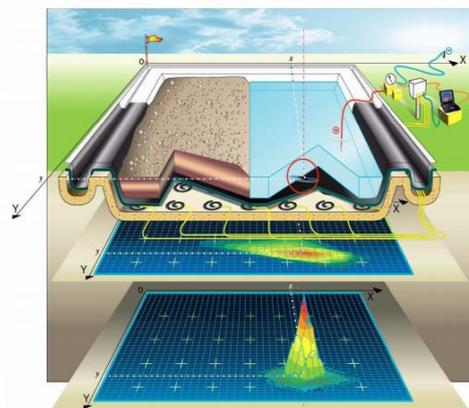
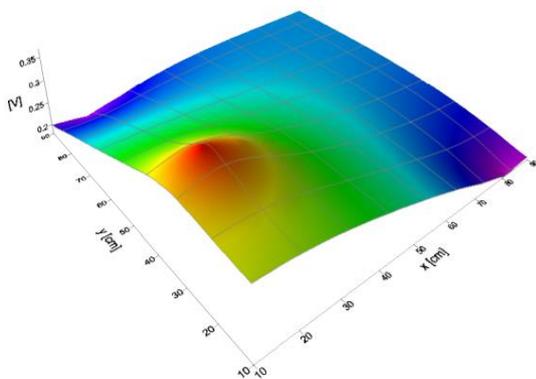
**Geotechnical Studies at COPPE (Graduate School of Engineering) - UFRJ (Federal University of Rio de Janeiro), Brazil (Con't)**



Figures 7, 8 and 9. Study of the effect of vetiver grass on the shear strength of a sandy soil



Figures 10 and 11. Simulation of vertical flow in a municipal solid waste landfill



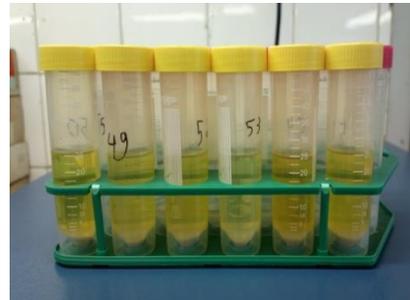
Figures 12 and 13. Application of geophysical methods (resistivity soundings) at landfills



Figures 14 and 15. Vetiver grass used to form vegetative strips to contain surface drainage and control erosion

## Research highlights

### Geotechnical Studies at COPPE (Graduate School of Engineering) - UFRJ (Federal University of Rio de Janeiro), Brazil (Con't)



Figures 16 and 17. Study to evaluate the concentrations of metals along highways

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#### Foundations and soil-structure interaction

Francisco Lopes, [flopes@coc.ufrj.br](mailto:flopes@coc.ufrj.br)

The main topics covered are: (i) prediction of settlements of shallow foundations, (ii) prediction of the bearing capacity of piles, including assessment of time effects (rate effects, creep and stress relaxation), (iii) pile behavior during driving (dynamic behavior) *versus* under static loads, (iv) load capacity of piles and shallow foundations in tension, (v) behavior of open excavations. In the study of these subjects the following methods are used: laboratory models (including the calibration chamber), field load tests, construction monitoring and numerical methods.

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#### In-situ testing and instrumentation

Fernando Danziger, [danziger@coc.ufrj.br](mailto:danziger@coc.ufrj.br)

The main topics covered are:

- (i) CPT and CPTU - COPPE/UFRJ produced a piezocone in 1985 and in 1996 introduced a dual pore pressure piezocone ( $u_1$  and  $u_2$ ). Tests have been performed in most regions of Brazil for both research and consulting. A significant database has been obtained, especially on very soft clays. Cooperation with NGI from the very beginning was established.
- (ii) DMT and SDMT - since 1985 DMT tests have been performed (SDMT from 2012), in a number of soil types.
- (iii) T-bar - A T-bar probe was produced in 2004 and has been used in very soft clays in Rio de Janeiro.
- (iv) VT - In cooperation with the Federal University of Pernambuco (UFPE) and the private company GROM, a vane test (VT) equipment was developed in 1998, with torque measurement close to the blade. It has been used in a number of sites in Brazil.
- (v) SPT monitoring - An SPT analyzer was purchased in 1998 and has been used to monitor SPT tests in a number of research and consultancy projects in Brazil.
- (vi) Torpedo-piezocone - In a partnership with PETROBRAS, a free-fall torpedo piezocone was developed, which measures cone resistance, sleeve friction, pore-pressures ( $u_1$  and  $u_2$ ) and temperature for offshore (deep-water) applications. The data acquisition system from PETROBRAS torpedo piles - which measures acceleration and rotation in three axes - was adapted to include the piezocone transducers.

## Research highlights

### Geotechnical Studies at COPPE (Graduate School of Engineering) - UFRJ (Federal University of Rio de Janeiro), Brazil (Con't)



Figure 18. Torpedo-piezocone



Figure 19. Calibration chamber testing

- (vii) Calibration chamber testing - The NGI calibration chamber, 1.22 m in diameter and 1.50 m in height, was donated to COPPE/UFRJ. Installed in the Willy Lacerda building, it has been used to perform CPT and monitored SPT in sands. Sand from Hokksund (Norway) and São Francisco (Niteroi, Brazil) have been used in research.
- (viii) Soil sampling - Good quality sampling of soft clays has been a major interest from the very beginning. A number of samplers have been used, including the Sherbrooke sampler, in cooperation with NGI. A new sampler was developed in 2013, and a patent required. Special procedures have been developed both in the field and in trimming samples in the laboratory.
- (ix) Bender elements - A device for bender elements produced by the University of Massachusetts, Amherst has been used to evaluate the quality of soil specimens. Comparisons between the shear wave velocity in the field (from the SDMT) and in the laboratory have been made.
- (x) Load tests - Instrumented load tests have been performed on piles and plates. Vertical uplift, lateral and inclined uplift ( $45^\circ$ ) tests have been recently performed on a model torpedo anchor/pile, in a joint research project with PETROBRAS. These tests have been carried out at Sarapuí II soft clay test site.

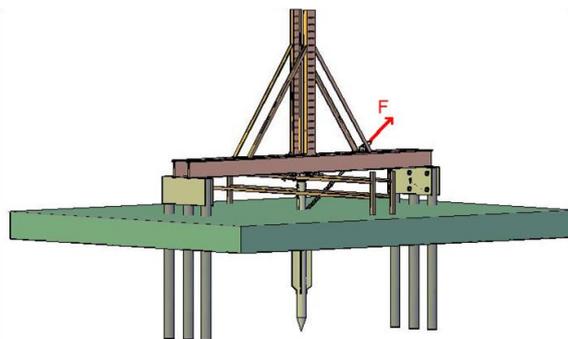


Figure 20. Torpedo-piezocone

## Research highlights

### Geotechnical Studies at COPPE (Graduate School of Engineering) - UFRJ (Federal University of Rio de Janeiro), Brazil (Con't)

- (xi) Instrumentation of foundations to earth works, for research and civil construction projects, including piezometers, inclinometers, load cells, pore-pressure cells, total stress cells; long term monitoring of settlements and loads in a building has been carried out.

#### Rheological behavior of soils

Ian Martins, [ian@coc.ufrj.br](mailto:ian@coc.ufrj.br)

The main topics covered are:

- (i) Development of equipment for laboratory testing, in special for rate or time dependent tests.
- (ii) Research on the rheological behavior of saturated clays - This research follows the works of Taylor and Merchant (1940), Taylor (1942), Bjerrum (1973) and Martins (1992) in which the viscous behavior of soils is taken into account. Results indicate that soil behavior is strongly affected by loading rate and temperature.
- (iii) Evaluation of earth works considering the viscous behavior of soils: embankments on clay and creeping slopes.

#### Pavement mechanics

Laura Motta, [laura@coc.ufrj.br](mailto:laura@coc.ufrj.br), Thiago Araújo, [fthiago@coc.ufrj.br](mailto:fthiago@coc.ufrj.br)

##### 1) Development and calibration of the new Brazilian design method of asphalt pavements

Fritzen (2016) used 45 experimental field segments built in the UFRJ campus to generate a transfer function that relates laboratory and field performance. This is a key step towards the calibration of the recently developed mechanistic-empirical Brazilian pavement design guide. This design guide is the result of a comprehensive study among many Brazilian universities in partnership with CENPES/PETROBRAS and DNIT, the Brazilian government agency for transportation infrastructure. Figure 21 shows this calibration curve, which was tested with results of experimental stretches from several parts of the country with a good fit.

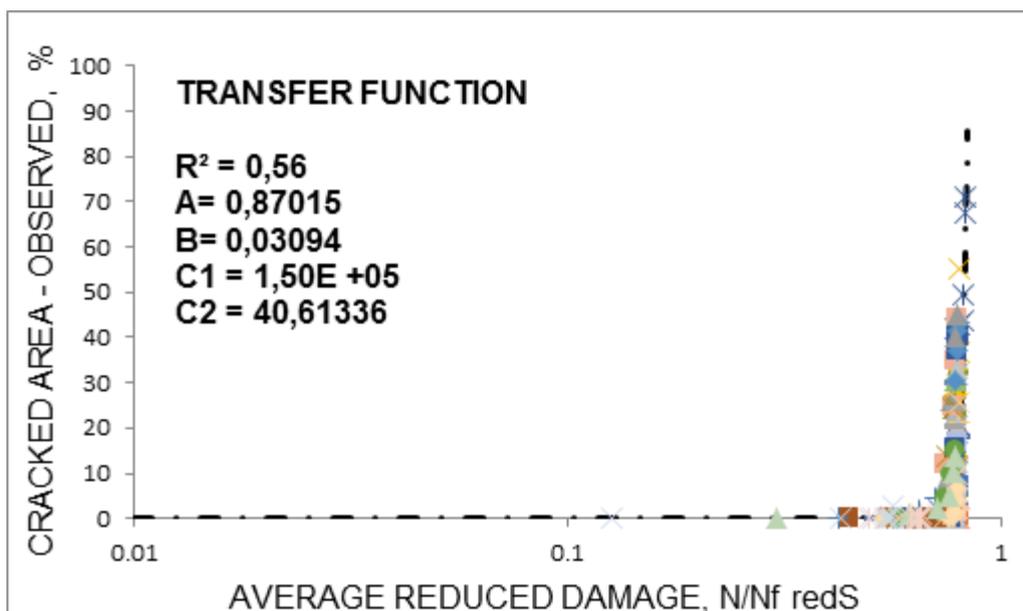


Figure 21. Average reduced damage of the 45 monitored field segments used in the calibration of the Brazilian mechanistic pavement design guide

**Research highlights**

**Geotechnical Studies at COPPE (Graduate School of Engineering) - UFRJ (Federal University of Rio de Janeiro), Brazil (Con't)**

**2) Aging assessment of binders, mastics and fine aggregate matrices (FAMs)**

Cravo (2016) studied the effects of aging in different asphaltic materials using techniques such as Infrared, Liquid Chromatography (SARA), Heithaus Parameter (Internal Compatibility), Nuclear Magnetic Resonance (NMR) and Molecular Weight Distribution. The research also evaluated the efficiency of lignin as a natural antioxidant agent and proposed a test for predicting the material stability to oxidation. Figures 22 and 23 show examples of rheological characterizations of the different materials evaluated in different scales.

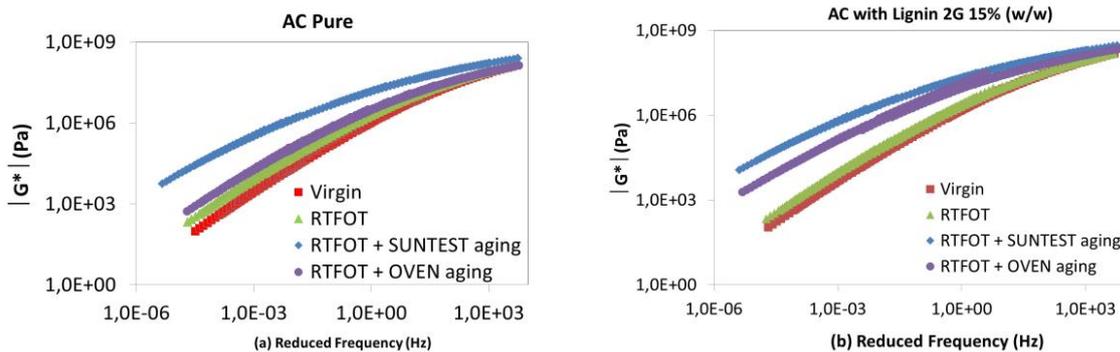


Figure 22. Dynamic shear modulus master curves for: (a) pure bitumen; (b) lignin-modified bitumen

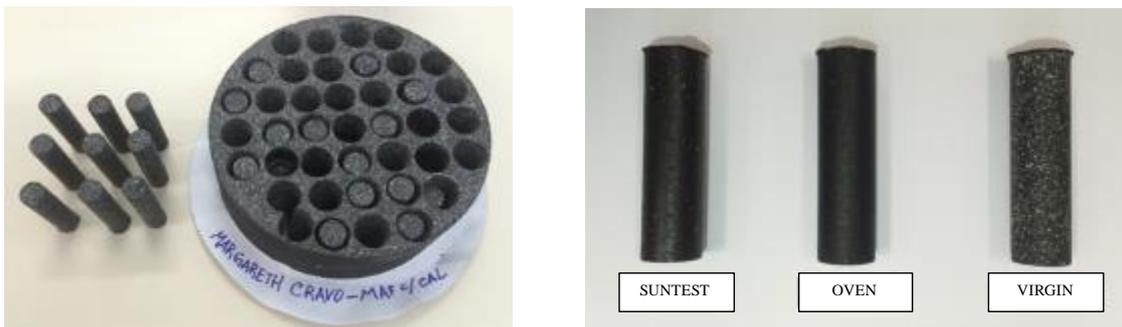


Figure 23. Study of FAM (asphalt binder + fine aggregates) aging

**3) Numerical modelling of deformations on railway pavements**

Rangel (2015) adopted the finite-element-based software Abaqus to simulate a railway trackbed and explicitly considered the different elements that compose real railroad structures. Computer simulations showed the need for the development of modern and robust models that allow the identification of the effects of different variables, such as loading levels, geometric characteristics and stiffness of the pavement layers, rail geometry, sleeper and fastening characteristics, among others, on the mechanical behaviour of the structure. Figures 24 and 25 show some modelling and simulations carried out.

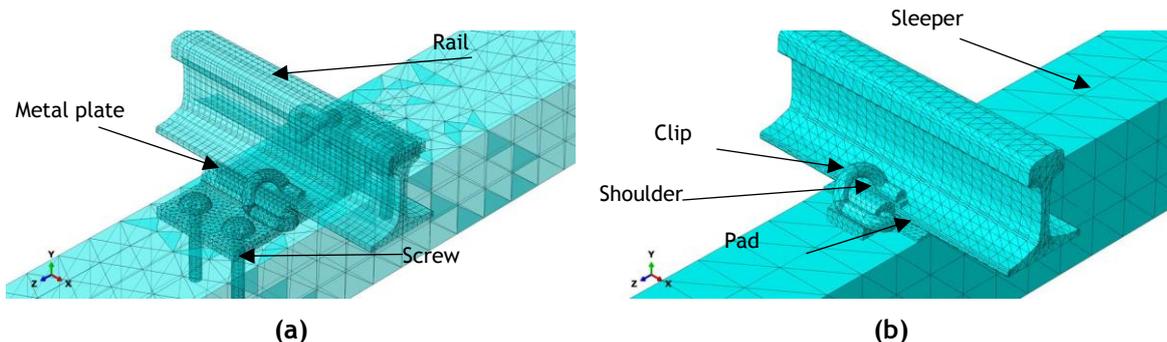


Figure 24. Simulation of the Pandrol e-clip fastening: (a) wood sleeper; (b) concrete sleeper.

## Research highlights

### Geotechnical Studies at COPPE (Graduate School of Engineering) - UFRJ (Federal University of Rio de Janeiro), Brazil (Con't)

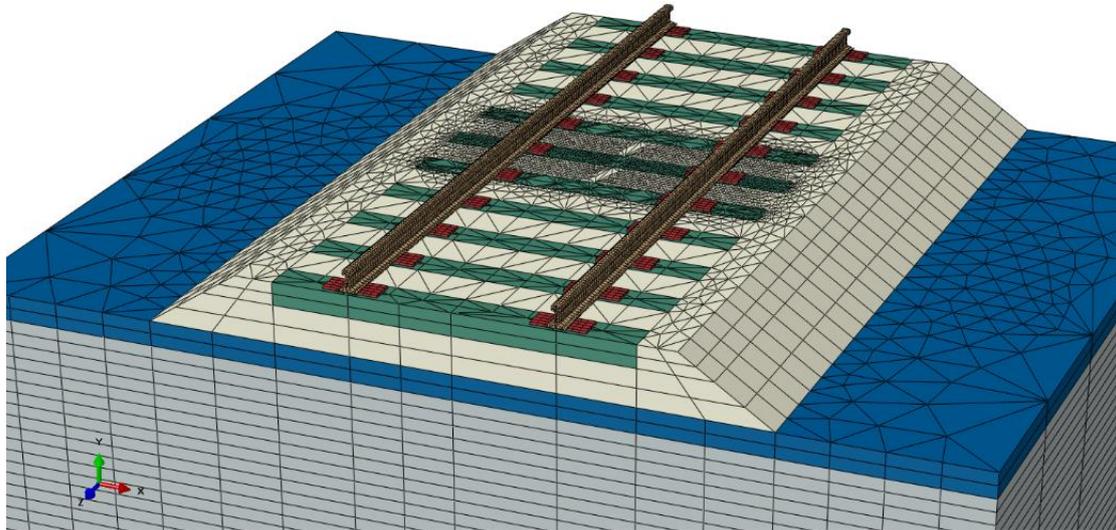


Figure 25. Simulation of a railway trackbed

#### **4) Microstructural and multiscale modelling of asphaltic materials and structures**

In the line of research of microstructural modelling of asphaltic materials, have been working on the development of a computational model based on the finite element method (FEM) for the simulation of the fracture behaviour of asphalt mixtures. An asphalt mixture virtual sample generator has been recently developed and allows the user to realistically reproduce key mix design and geometric parameters of the mixture microstructures such as gradation, spatial distribution and orientation of particles, size and spatial distribution of voids, among others. The virtual samples have been used in virtual mechanical testing of the asphalt mixture composite based on component characteristics, both with and without damage. Numerical-experimental procedures have also been developed for the characterization of component characteristics, including a protocol for the determination of the complex material fracture characteristics, which are temperature- and rate-dependent. A FEM numerical model that incorporates the material viscoelastic behaviour and the cohesive zone concept to simulate the fracture damage responses has also been developed and used.

The microstructural modelling of asphaltic materials and mixtures based on their component characteristics is part of an even broader effort to develop techniques for multiscale modelling. Concepts related to micromechanics, such as the determination of representative volume elements, are considered and the multiscale model allows the prediction of the behaviour of a given global scale from another given smaller scale, often named as local scale. At the local level, in which the heterogeneity of the material is considered, damage by fracture, for example, is modelled explicitly, as in the microstructural modelling approach. The boundary conditions imposed on virtual samples on a local scale result in the formation and propagation of microstructural cracks and the consequent reduction in stiffness of the material. This reduction is considered in the simulation of the global scale, in which the material is modelled as a homogeneous body. The continuous interaction between the simulations on local and global scales enables the overall behaviour of the material to be predicted. Since on the global scale the material is considered homogeneous, the multiscale modelling approach becomes an attractive methodology that results in significant savings on the computational cost and time. The multiscale modelling carried out considers smaller and smaller local scales and includes research for the characterization of the mechanical behaviour of asphalt binders from microstructural characteristics of their components, determined using an atomic force microscope (AFM). Figure 26 shows a representative scheme of multiscale modelling.

## Research highlights

### Geotechnical Studies at COPPE (Graduate School of Engineering) - UFRJ (Federal University of Rio de Janeiro), Brazil (Con't)

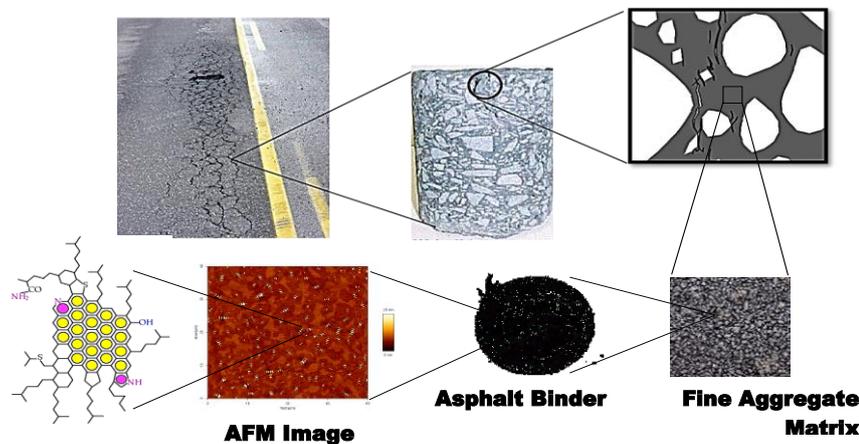


Figure 26. Representative scheme of the multiscale modelling of materials and asphalt mixtures developed by the pavement mechanics research group of COPPE/UFRJ.

#### 5) Stabilization of laterite and soils with cement, lime and chemicals.

Francisco Casanova, [casanova@coc.ufrj.br](mailto:casanova@coc.ufrj.br)

Soil stabilization has been studied since 1978, mainly covering the mechanisms of the process and the use of inorganic waste as fillers (for particle size correction) and pozzolans (adjuvants agents aimed at the partial replacement of cement). The purpose is to manufacture building elements of low carbon and low embodied energy (green bricks of stabilized soil, shaped by cold static compression). Among the types of waste, one can mention: rice husk ash and sugar cane bagasse ash as pozzolan and blended cements; blast furnace slag (quickly cooled with water under pressure) cement compounds and super sulphated cement; slag from steel plant blast furnace (aged) fillers and stabilized bricks; refuse from ceramic potteries used as medium and fine aggregate and as pozzolan (if poorly calcined); ash from electric ovens and thermo-electric plants used as fillers and pozzolan; stone dust and limestone dust fillers and mortars; chemical gypsum: blocks and bricks as pozzolan activator; red mud stabilized blocks / bricks, alkaline additive as pozzolan activator; mineralized Sawdust (mineralized) in Hatschek tiles (fibre cement); sisal fibres (mineralized); carbide lime as a substitute for commercial lime; diatomite (normal and activated) as pozzolan; perlite (absorbent) as pozzolan; casting for stabilized bricks; milled quartz and waste from marble shops and rock artefacts factories as fillers and pozzolan (granite powder); construction and demolition waste as granular material. Recently, an organic copolymer as an adjunct of lime and cement has been successfully applied to the stabilization of sandy and clay latosols, especially in the requirement of resistance to the action of water. Figure 27 shows constructions where bricks produced with the technique of low energy soil cement, produced under the guidance of Prof. Casanova, in Rio de Janeiro. They were also applied in other parts of the country, and introduced in other developing countries.



Figure 27. Example of low-cost soil-cement / waste dwellings in Rio de Janeiro

## Research highlights

### Geotechnical Studies at COPPE (Graduate School of Engineering) - UFRJ (Federal University of Rio de Janeiro), Brazil (Con't)

#### Soft soils: experimental and numerical studies

Márcio S. S. Almeida, [almeida@coc.ufrj.br](mailto:almeida@coc.ufrj.br)

The Soft Soil's group studies the full range of issues involved in this topic, including site investigation, analytical and numerical calculations and monitoring and interpretation of field data. Some selected recent studies are summarized below:

#### 1) Granular columns encased with geotextiles

Instrumented test embankments have long been carried out at COPPE-UFRJ. A recent example is the case of an embankment over a 6 x 6 mesh of granular encased columns on a soft soil deposit about 8.5 m thick. Figure 28 shows the measured vertical stresses on column and soft soil together with results of numerical analyses, where numerical and experimental results show good agreement. As expected, the vertical stresses on columns are greater than on the surrounding soil due to the arching effect.

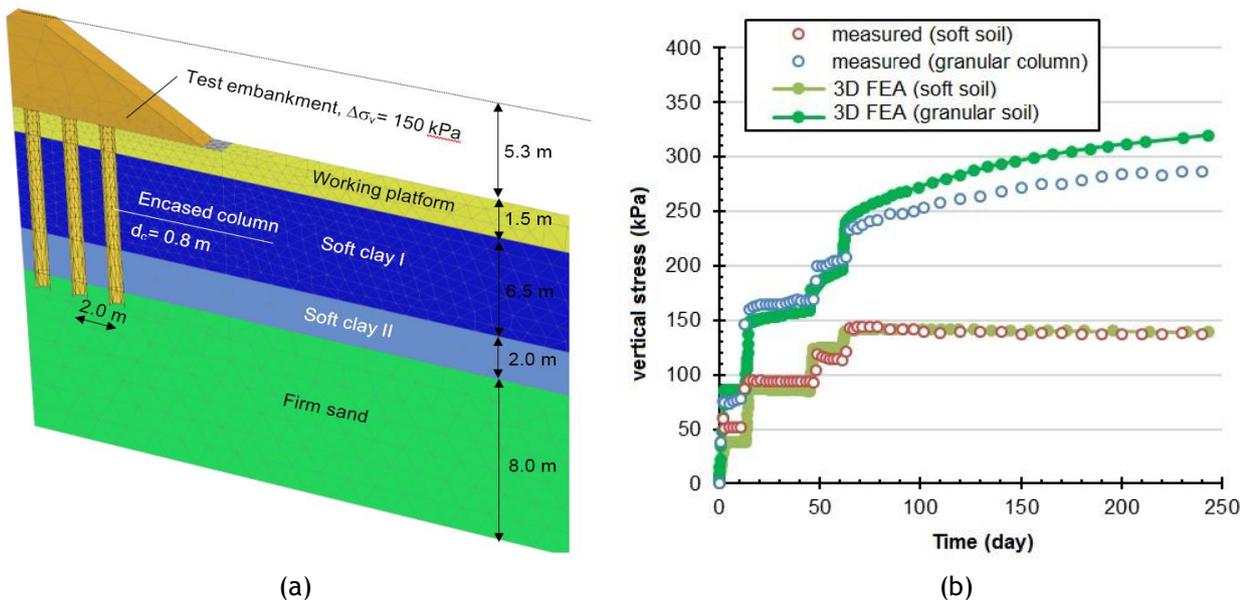


Figure 28. Test embankment on encased granular columns: (a) 3D numerical model; (b) measured and calculated vertical tensions

#### References:

Almeida, M., Hosseinpour, I., Riccio, M., and Alexiew, D. (2015) "Behavior of Geotextile-Encased Granular Columns Supporting Test Embankment on Soft Deposit." *Journal of Geotechnical and Geoenvironmental Engineering*. v. 141, n3. P.04014116.

Hosseinpour, I, Almeida, M.S.S., Riccio, M. (2015). Full-scale load test and finite element analysis of soft ground improved by geotextile-encased granular columns. *Geosynthetics International*. v.8, p.1-11.

#### Related stone column studies:

Almeida, M., Lima, BL, Riccio, M., Jud, H., Cascão-Almeida, M. and Roza, F. "Stone column field test: Monitoring data and numerical analyses." *Geotechnical Engineering Journal of the SEAGS & AGSSEA* 45, no. 1 (2014): 1-10.

## Research highlights

### Geotechnical Studies at COPPE (Graduate School of Engineering) - UFRJ (Federal University of Rio de Janeiro), Brazil (Con't)

#### 2) Vacuum-assisted consolidation

The prediction of negative pore pressures or horizontal displacements at the edge of the embankment is not feasible with classical analytical models in the case of vacuum-assisted consolidation. In order to make this feasible vacuum consolidation with prefabricated drains, not previously done by numerical modelling, was then developed. The assessment of the overall numerical model was done for a test embankment built on a structured clay soil for which the S-CLAY1S constitutive model was adopted (Fig. 29). The figure below shows results of measured and calculated settlements with good agreement between the two sets of data.

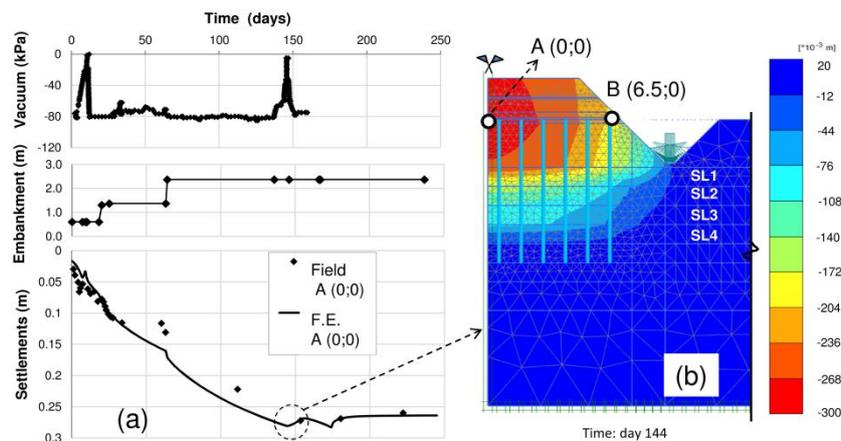


Figure 29. Numerical modelling of embankment using S-CLAY1S

#### Reference:

*Modelling of laboratory tests on Saint-Roch-de-l'Achigan clay with S-CLAY1S model, Deotti, L O G, Karstunen, M., Cascão-Almeida, Almeida, M S S, International Journal of Geomechanics, ASCE, in print.*

#### 3) Studies on piled embankments with geosynthetic platform: physical and numerical modelling

The numerical modelling of structured embankments with geosynthetic platform has complemented centrifuge modelling studies (COPPE-IFSTTAR partnership). 3D numerical analyses below show the influence of embankment height on the settlements, noting that for the height  $H = 3.2$  m, no differential settlements occur on the surface.

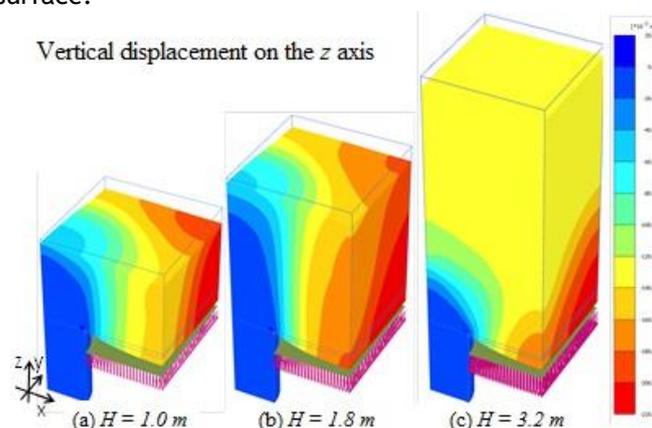


Figure 30. 3D visualization of the vertical displacement; post with diameter = 1.0 m and spacing  $s = 2.82$  m; geosynthetic modules  $J_x = 4760$  kN/m;  $J_y = 2960$  kN/m.

## Research highlights

### Geotechnical Studies at COPPE (Graduate School of Engineering) - UFRJ (Federal University of Rio de Janeiro), Brazil (Con't)

#### References:

Blanc, M., Rault, G., Thorel, L. and Almeida, M. (2013) *Centrifuge investigation of load transfer mechanisms in a granular mattress above a rigid inclusions network*. *Geotextiles and Geomembranes* 36: 92-105.

Fagundes, D., Almeida, M., Girout, R., Blanc, M. and Thorel, L. (2015) "Centrifuge modelling of unreinforced piled embankments". *Geotechnical Engineering ICE, Thomas Telford*, 168(6), 514-525.

#### Centrifuge Modelling

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Maria Cascão F. Almeida, [mariacascão@poli.ufrj.br](mailto:mariacascão@poli.ufrj.br)

Post-doc José Renato M. S. Oliveira, [jrmso70@gmail.com](mailto:jrmso70@gmail.com)

The geotechnical drum centrifuge of COPPE-UFRJ was installed in 1995 in the Geotechnical Laboratory of the Federal University of Rio de Janeiro, and was, at the time, the first device of its type installed at the University in Brazil. The centrifuge has a diameter of 1.0 m and a capacity of 90g-ton and began operating in 1996, the first studies being related to the transport of heavy metals on soils. Since 2001, successive research related to pipeline geotechnics has been carried out (through master's and doctorate studies) in partnership with companies, particularly PETROBRAS and TECHNIP, showing the special vocation of this equipment for the oil and gas industry.

The first tests carried out involved the study of the snaking of shallow pipelines by thermal buckling buried in clay soil (Figure 31), simulating a similar accident in Guanabara Bay in 2000.

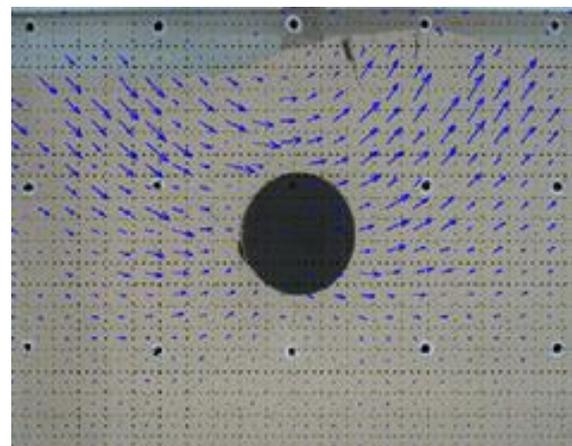
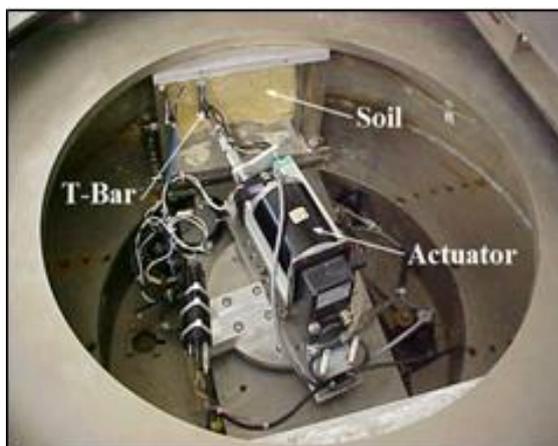


Figure 31. Study of the snaking of shallow pipelines buried in clay

Further research followed, investigating the soil-pipeline interaction both horizontally and vertically in clay and sand. Studies on the behaviour of penetration testing with cone and T-bar were also carried out in this period. More recently, studies involving the redistribution of stresses in pipelines buried in clay soils subjected to settling induced by the construction of embankments (Figure 32) were carried out. Recently, studies on submarine slopes have been started.

## Research highlights

Geotechnical Studies at COPPE (Graduate School of Engineering) - UFRJ (Federal University of Rio de Janeiro), Brazil (Con't)

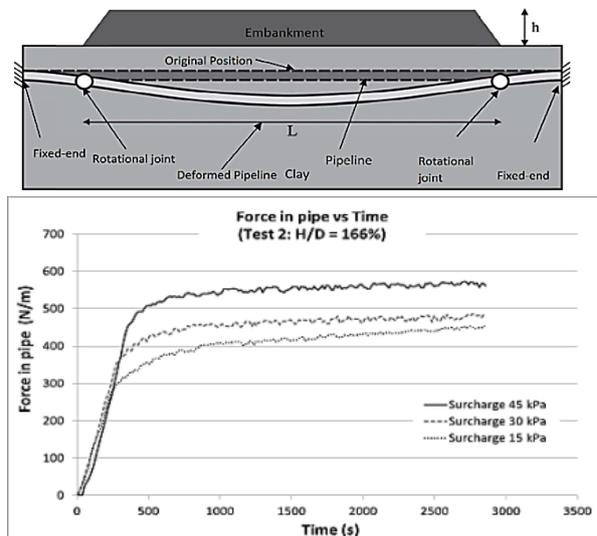
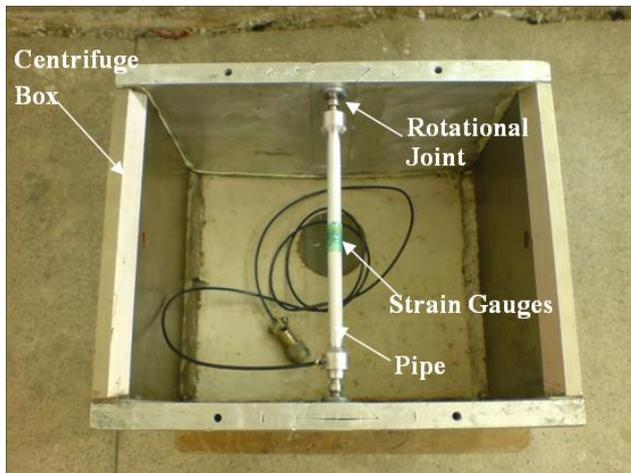


Figure 32. Study of buried pipelines subjected to embankment loading

In 2011, a new centrifuge, this time an arm one, was incorporated into the Geotechnical Laboratory of COPPE-UFRJ, thereby setting up the Centrifuge Modelling Laboratory. The new equipment has a diameter of 1.6 m and began operating in 2012. The two centrifuges can be seen in Figure 33.



Figure 33. The arm centrifuge (left) and the drum centrifuge (right)

New physical models were developed to study the soil-duct interaction, through the lateral, axial and vertical movement of pipelines in submerged models, this time involving a controlled loading system capable of maintaining the applied vertical load constant through a feedback control system. Figure 34 shows an axial stress test, where the evolution of soil resistant forces versus pipeline movements can be observed.

## Research highlights

### Geotechnical Studies at COPPE (Graduate School of Engineering) - UFRJ (Federal University of Rio de Janeiro), Brazil (Con't)

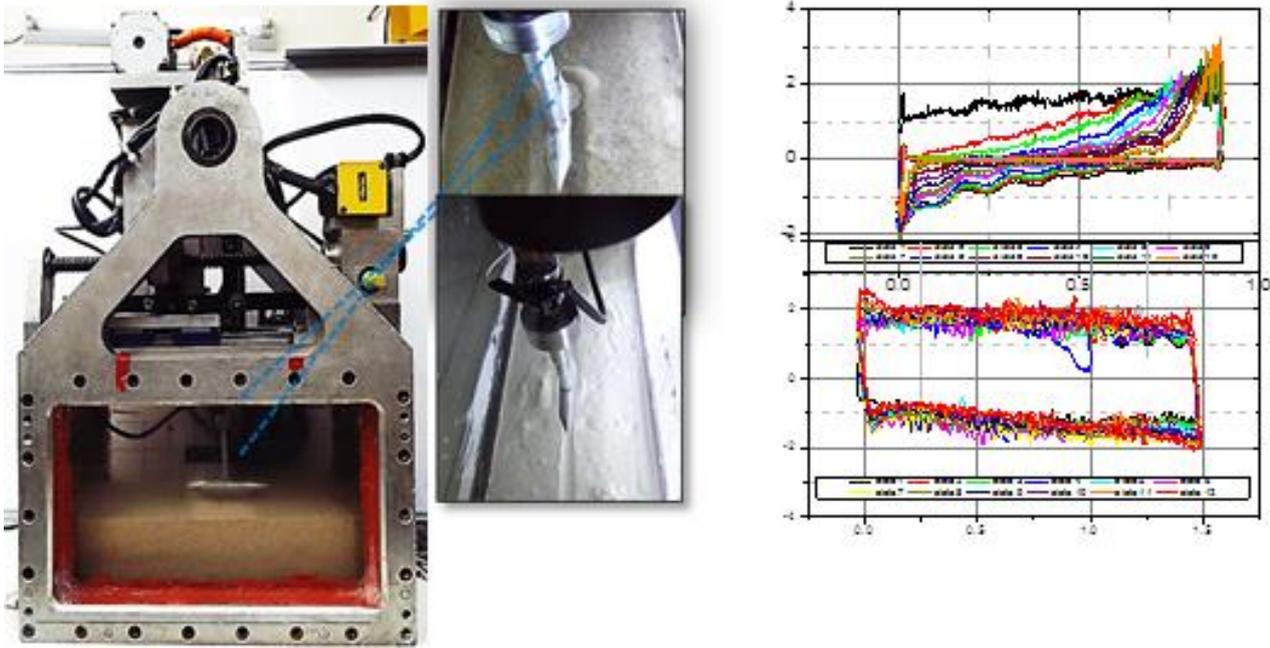


Figure 34. centrifuge test configuration (left) and results after 12 cycles of interaction (right)

COPPE-UFRJ's centrifuge modelling group has produced a dozen DSc. theses and MSc. dissertations on issues related mainly to soil-structure interaction, foundations and landfills.

#### References:

- Almeida, M. S. S.; Oliveira, J.R.M.S.; Rammah, K.I.; Trejo, P. C. (2013) "Investigation of bearing capacity factor of T-bar penetrometer at shallow depths in clayey soils". *Journal of Geo-engineering Sciences*, vol. 1, p. 1-12.
- Oliveira, J.R.M.S.; Almeida, M.S.S.; Almeida, M.C.F. & Borges, R.G. (2010) "Physical Modeling of Lateral Clay-Pipe Interaction" - *Journal of Geotechnical and Geoenvironmental Engineering*, vol.136, pp. 950-956.
- Oliveira, J.R.M.S.; Almeida, M.S.S.; Motta, H.P.G. & Almeida M.C.F. (2011) "Influence of penetration rate on penetrometer resistance" - *Journal of Geotechnical and Geoenvironmental Engineering*, vol. 137(7), pp. 695-703.
- Rammah, Khader I. ; Borges, Ricardo G. ; Almeida, Marcio S. S. ; Almeida, Maria C. F. ; Oliveira, Jose R. M. S. . (2014) Centrifuge modelling of a buried pipeline below an embankment. *International Journal of Physical Modelling in Geotechnics*, v. 14, p. 116-127.

**Research highlights**

**Geotechnical Studies at COPPE (Graduate School of Engineering) - UFRJ (Federal University of Rio de Janeiro), Brazil (Con't)**

**Applied Geotechnics in Environmental Studies**

Prof. Maria Claudia Barbosa, [mclaudia@coc.ufrj.br](mailto:mclaudia@coc.ufrj.br)

**1) Cover systems for solid waste**

The configuration of the cover system depends on the desired control and the local climate, since it operates in the hydrologic cycle. When the main purpose is to minimize the generation of acid mine drainage (AMD) in the waste, controlling the entry of oxygen is more important than the entry of water. A study was carried out in the laboratory, in numerical modelling and in a pilot plant unit in the field, of the alternative of a double capillary barrier cover for the condition of a humid tropical climate, in partnership with CETEM [Centre for Mineral Technology]. The configuration of the proposed cover (Cell 4) and the results observed in the field for the cell without a cover (Cell 1) and with different systems of cover (Cells 2, 3 and 4) are shown in Fig. 35. The orange colour of the leachate from Cell 1 in Fig. 35 (b) represents the release of oxidized Fe in the solution.

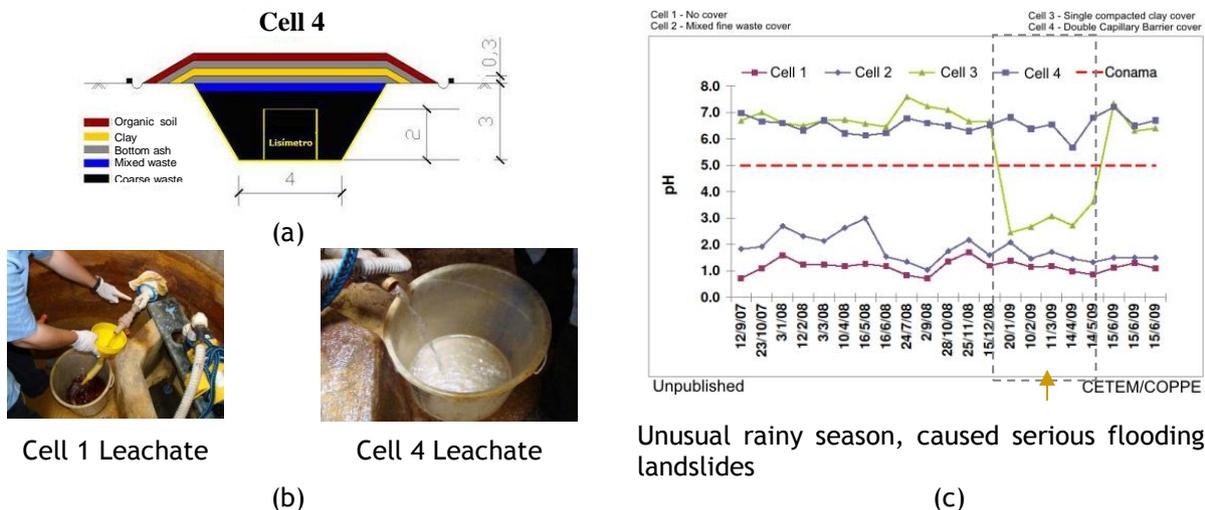


Figure 35. Double capillary barrier cover to control the generation of AMD

**2) Electrokinetics in soils**

The application of an electric field on the soil causes a set of processes, including electro-osmosis, which is the flow of water generated by the movement of ions under the action of the electric field. Electro-osmosis also occurs in electrical grounding systems, and can contribute to drying around the electrodes. Figure 36 shows results of the analytical modelling of the problem using Mathematica © to solve the equations, for a simplified axi-symmetric condition.

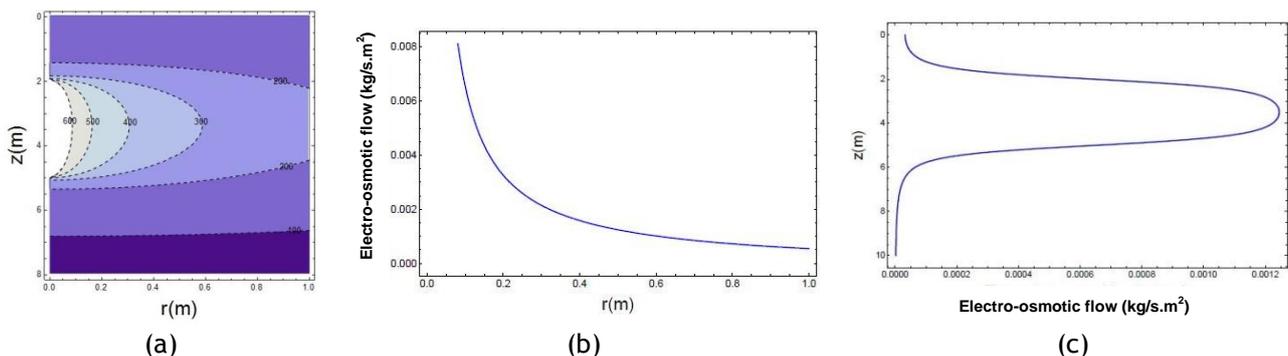


Figure 36. Ground electrode with L = 3.0m, current of 30A, homogeneous soil with electrical resistivity of 100Ωm

## Research highlights

### Geotechnical Studies at COPPE (Graduate School of Engineering) - UFRJ (Federal University of Rio de Janeiro), Brazil (Con't)

#### Reinforced soils

Mauricio Ehrlich, [me@coc.ufrj.br](mailto:me@coc.ufrj.br)

Monitoring of real walls, physical and numerical modelling and analytical studies have supported this line of research. The large-scale physical model studies carried out at the COPPE/UFRJ Laboratory of Physical Models [Institute of Post-graduation and Research in Engineering] may represent a 7-m-high reinforced soil walls (considering surcharge load up to 100 kPa).

#### 1) Reinforced soil walls

So far, 42 walls have been carried out in the physical modelling laboratory and four real walls have been monitored. The monitoring conducted included measuring loads along the reinforcements and movements of the walls. It is shown that, the stiffer the reinforcement system and the higher the stresses induced during compaction, the higher are the tensile stresses that must be resisted by the reinforcements. The results also call attention to the combined effect of the rigidity of the facing and the restriction on the movement at the base of the blocks facing, and the external loading application.



#### 2) Soil nailing

With respect to soil nailing, specific aspects of the technique in soil of residual origin have been verified. Three actual field works were monitored, and numerical studies and physical modelling were carried out. One of the works monitored is a 31-m-deep excavation. The study called attention to the effect of the reliquiaie soil layers on the behaviour of excavations in young residual soils. The performed numerical and laboratory studies highlight the effect of differential settlement near the face on the mobilization of bending moments in nails. In addition, laboratory and field studies indicate that precast blocks may be a good option for the facing of this kind of work.

#### References:

- Ehrlich, M., Mirmoradi, S.H., Saramago, R. P. Evaluation of the effect of compaction on the behavior of geosynthetic-reinforced soil walls. *Geotextiles and Geomembranes*, 2012, pp. 108-115.
- Ehrlich, M., Mirmoradi, S. H. Evaluation of the Effects of Facing Stiffness and Toe Resistance on the Behavior of GRS Walls. *Geotextiles and Geomembranes*, 2013, pp. 28-36.
- Riccio, M., Ehrlich, M., Dias, D. Field monitoring and analyses of the response of a block-faced geogrid wall using fine-grained tropical soils. *Geotextiles and Geomembranes*, 40 (2), 2014, pp. 127-138.
- Mirmoradi, S. H., Ehrlich, M. Numerical Evaluation of the Behavior of GRS Walls with Segmental Block Facing under Working Stress Conditions *JGGE, ASCE*, 141 (3), 2015, 04014109.
- Ehrlich, M., Silva, R. C. Behavior of a 31m high excavation supported by anchoring and nailing in residual soil of gneiss. *Engineering Geology* 191, 2015, pp. 48-60.
- Mirmoradi, S. H., and Ehrlich, M. Evaluation of the effect of toe restraint on GRS walls, *Transportation Geotechnics*, 2016, in press.
- Ehrlich, M., and Mirmoradi, S. H. A Simplified Working Stress Design Method for Reinforced Soil Walls, *Géotechnique*, 2016, in press.

## Research highlights

### Geotechnical Studies at COPPE (Graduate School of Engineering) - UFRJ (Federal University of Rio de Janeiro), Brazil (Con't)

#### Natural Slopes

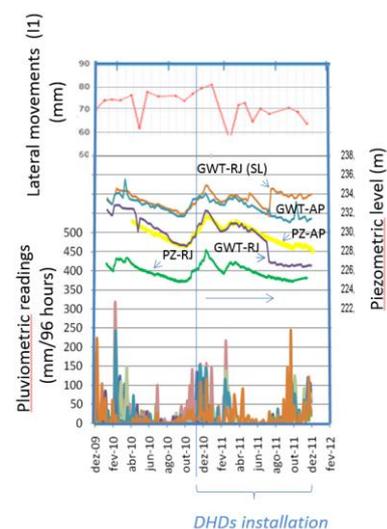
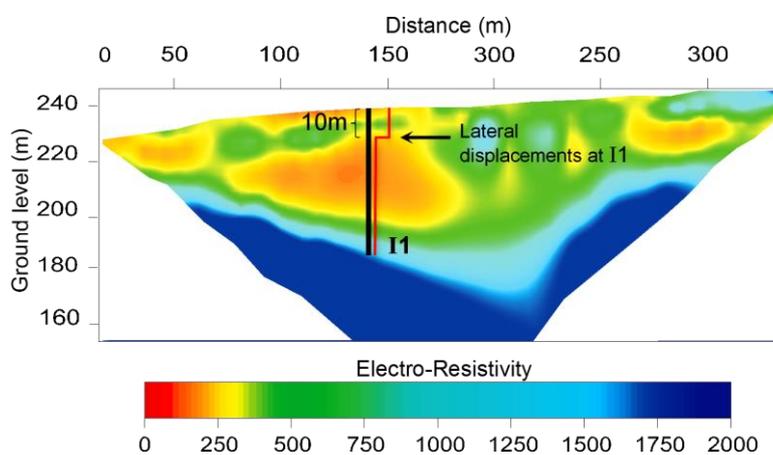
Mauricio Ehrlich, [me@coc.ufrj.br](mailto:me@coc.ufrj.br), Willy Alvarenga Lacerda, [willy@coc.ufrj.br](mailto:willy@coc.ufrj.br)

The main activities are centered on hill slope problems and the determination of the geotechnical properties of tropical soils derived from gneiss and granite. Studies have included the study of landslides and colluviums mobility. These items were included in the proposal of the National Institute of Rehabilitation of the hillside plain systems, REAGEO, under the auspices of the National Research Council of Brazil (CNPq) and the Foundation for the Support of Research of Rio de Janeiro State, FAPERJ. This Institute, REAGEO, manages the physical and geotechnical aspects related to the environment especially the stability of both natural slopes and man-made slopes. The problems with occupation of plains lies in their inter-relation and geomorphological aspects related to erosion. REAGEO also studies innovative techniques to be applied in degraded environments such as reinforcement of slopes and retaining walls, improvement of investigation methods on soft soils and their stabilization.

The cities of Rio de Janeiro, Niterói, Angra dos Reis and the Mountain Region (Teresopolis, N. Friburgo and Petrópolis) were strongly affected by strong storms and suffered numerous landslides with loss of life and heavy material damage. Slope areas of the mountain region of Rio de Janeiro have been accompanied with the support of CRT [company responsible for the Rio-Teresópolis highway], the ANTT [National Agency of Land Transport] and the Rio de Janeiro City Council with the support of GEO-RIO [Geotechnical Institute of Rio de Janeiro].

#### 1) Rainfall, water level and movements on slopes

On the BR116 in RJ, a highway located in Serra Fluminense [the mountain region of Rio de Janeiro state] monitoring of slopes has been carried out for about eight years, using piezometers, water-level meters, inclinometers and automatic rain gauges. The monitored slopes, in general, have problems associated with drainage. In February 2005, under an extreme rainfall condition, it was verified the rupture of 40 m length of the embankment at km 87.3. The collapsed soil mass of 10 m depth, also involved part of the embankment foundation of natural soil. At km 101, there had been a long history of slow movements. There is a paleotalus there, which, in the stretch that the road crosses is about 70 m deep and 350 m wide. The monitoring made it possible to correlate the horizontal movements to the variations in the groundwater table levels. Based on the results of this study, deep and shallow drainage has been implemented, aiming to keep the groundwater table level below the critical position that leads to movement and, since then, the movement has ceased. From January 2012, the monitoring was extended also to km 29 (four vertical inclinometers, two electric and two Casagrande type piezometers, two water-level meters). This location has similar conditions to km 101; the movements have been also controlled through deep drainage.



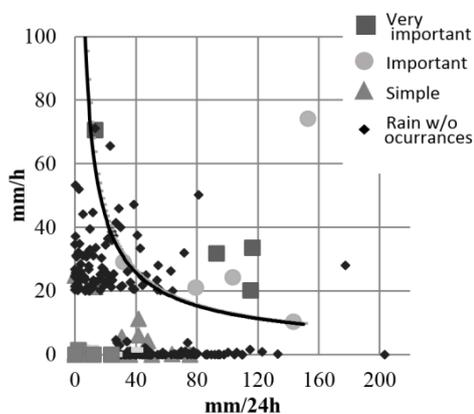
## Research highlights

### Geotechnical Studies at COPPE (Graduate School of Engineering) - UFRJ (Federal University of Rio de Janeiro), Brazil (Con't)

#### 2) Critical thresholds for landslides

Also on the BR116 in RJ, warning criteria has been developed for the occurrence of landslides, under extreme weather conditions. Five automatic rain gauges were installed at specific points along the highway and a correlation was established between landslides and rainfall events. The study highlights the importance of the geological, geotechnical and geomorphological characteristics of the different locations in their behaviour. In the mountain region, in line with the geological-geomorphological conditions of this stretch of the highway, the hourly intensity in association with the daily-accumulated value (mm/h x mm/24h) led to better correlations between rainfall and landslides. The slopes in this region are steep, the bedrock is very fractured and the top layers of soil have small thicknesses and that lead to the rapid flow of surface water and also of the infiltrated water. On other stretches of the highway the soil layers, commonly, are thick and slopes are not steep, leading to the accumulation of water; landslides are controlled by the accumulated value of 75mm / 96 hours.

Analyses were also carried out related to the variations over time of the response of the slopes of the Municipality of Rio de Janeiro to the occurrence of landslides, in extreme weather conditions. The city of Rio de Janeiro has geological and geomorphological characteristics that may lead to the occurrence of mass movements, and the increasing population density in mountainous areas exacerbates the process. For this study, two different periods were chosen for comparison, from 1998 to 2002 and from 2010 to 2012. GEO-RIO released monitoring results, including data from automatic pluviographs with observations every 15 minutes. For the two periods mentioned, critical rainfall thresholds were defined using rainfall events and their corresponding mass movements. As expected, the interventions on the slopes had a beneficial effect on the stability of the city's slopes and an increase of the critical thresholds for landslides. However, the disorderly occupation in areas of high susceptibility to landslide tended to aggravate these indexes in some places.



#### 3) Ochre formation in drainage systems

With regard to drainage conditions, a common occurrence is the clogging of drains by ochre, a muddy orangish-coloured substance consisting of a biofilm formed by iron-bacteria. Laboratory studies have highlighted the dynamics of biofilm formation in ochre formation on geotextile filters. Recent research has included different conditions of aeration of the filter interface, and stressed that the submersion of these did not stop, but reduced, the speed of the process.

#### 4) Colluvial slopes

Several cases of slope instability in colluvia have been studied, such as the Urubu's Hill landslide (1974), the Soberbo Road debris flow (1988 to 1992 and 2004), active moving colluvia in Angra dos Reis, Coroa Grande, both in the Rio de Janeiro State, and two colluviums in the Curitiba-Joinville highway, in the State of PARANÁ. (1990 TO 1995). Field measurements showed that these colluvia present typically angles between 15 and 18 degrees, and initiate their movement when the accumulated 25-day rainfall attains a value over 200 mm.

## TC Report

### TC308 – Energy Geotechnics

#### Introduction

To organize the growing activity in the area of Energy Geotechnics, the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE) launched the Technical Committee TC308 on 'Energy Geotechnics' during the 18<sup>th</sup> ICSMGE held in Paris, in July 2013. The aim of this article is to summarize the main activities the TC308 has conducted so far and the ones that are planned for the coming years.

This contribution comprises the following main parts:

- OVERVIEW
- TC308 TASK FORCES.
- 1ST INTERNATIONAL CONFERENCE ON ENERGY GEOTECHNICS (ICEGT-2016)
- BARCELONA SYMPOSIUM ON ENERGY GEOTECHNICS - SEG-2015
- **ERROR! REFERENCE SOURCE NOT FOUND.**
- OTHER PAST EVENTS
- SUMMARY OF UPCOMING EVENTS
- PUBLICATIONS ORGANIZED BY THE TC308

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#### 1 Overview

In the last few years geotechnical engineering has expanded its domain into the field of Energy Geotechnics. This has led to the study of the behavior of soils and rocks under complex and extreme conditions involving mechanical, hydraulic, thermal, and geochemical coupled actions. This branch of geotechnical engineering will play a fundamental role in the near future due to the increase in energy demands in the next decades associated with economic development and population growth worldwide. Geotechnical engineering is often at the core of the energy challenge, from production and transportation, to waste management and carbon sequestration. The goal of geotechnical engineers is to provide sustainable geotechnical solutions for these energy related society's needs.

The TC308 has (around) 50 official members (i.e. TC officers, members and corresponding members). The TC308 is growing very fast and is actively working for recruiting more members. More than 120 colleagues have expressed their interest in being updated through our email-list on the TC308 activities.

Basic information about the TC308 can be found on the ISSMGE website:

<http://www.issmge.org/en/technical-committees/impact-on-society/641-energy-geotechnics>

The TC308 has developed a website that provided very detailed information about the committee. This site is updated periodically with the main TC308 news.

<https://sites.google.com/site/energygeotechnics/>

The TC308 has also developed a group in the Geo World network.

<http://www.mygeoworld.info/groups/profile/65920/energy-geotechnics-tc308>

A brief summary of the Terms of Reference is presented below. More detailed information can be found at the [TC308 website](#).

The ISSMGE TC308 has several missions, including:

- to disseminate knowledge and practice in the area of soil mechanics and geotechnical engineering associated with Energy Geotechnics;
- to establish guidelines and technical recommendations within the Energy Geotechnics subject area;
- to organize specialty conferences, symposiums and workshops;
- to interact with industry and other organizations working in areas related to the TC308 specialist subject.

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**TC308 – Energy Geotechnics**

TC308 Leadership Team:



**Chair**  
 Dr. Marcelo Sánchez  
 Texas A&M University, USA



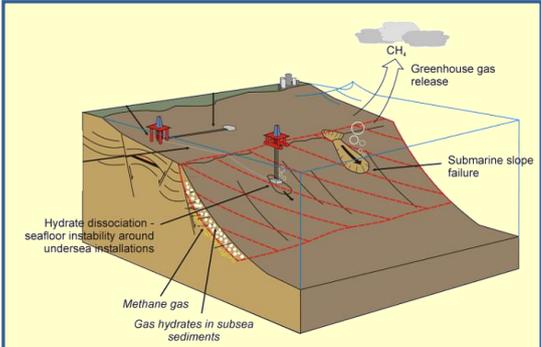
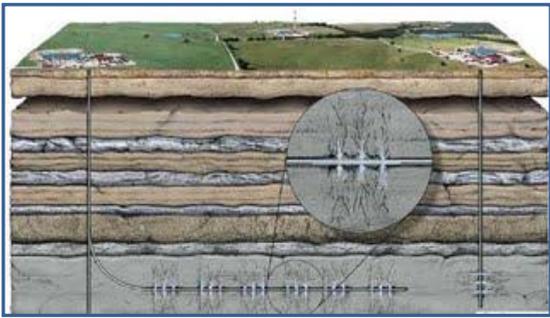
**Vice-Chair**  
 Dr. Kenichi Soga  
 Cambridge University, UK



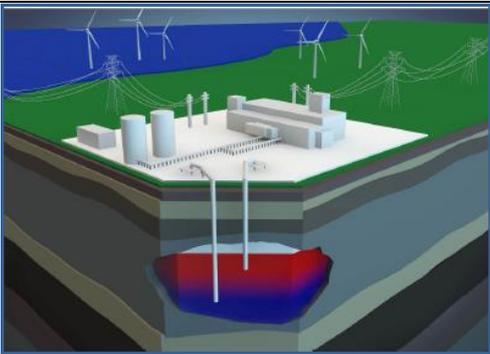
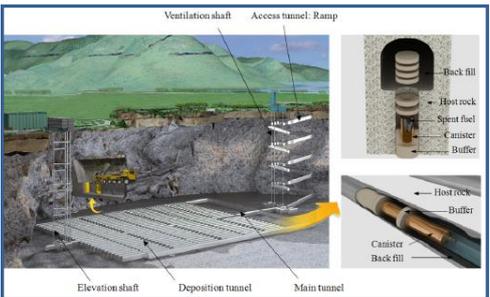
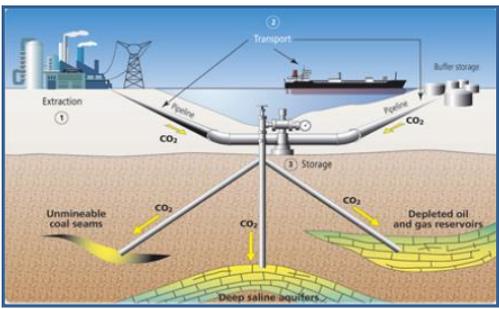
**Secretary**  
 Dr. Malek Bouazza  
 Monash University, Australia

The activity of the TC308 is organized in eight main Task Forces briefly discussed below. One Task Leader has been appointed per Task Force.

**2 TC308 Task forces**

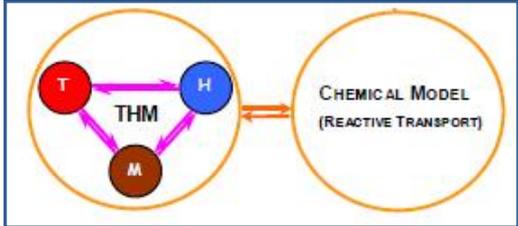
<p><b>I) Gas Hydrate Sediments</b> <a href="#">[Read more]</a></p>		
<p><b>Task Leader:</b>                  Dr. J. Carlos Santamarina                  (KAUST University, KSA)</p>		
<p><b>II) Unconventional Hydrocarbon. Hydraulic Fracturing</b> <a href="#">[Read more]</a></p>		
<p><b>Task Leader:</b>                  Dr. Leonardo Guimarães                  (University Federal of Pernambuco, Brazil)</p>		

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**TC308 – Energy Geotechnics**

<p><b>III) Energy Geo-Structure and Storage of Thermal Energy in the Ground</b> <a href="#">[Read more]</a></p>		
<p><b>Task leader:</b>                   Dr. Guney Olgun.                  (Virginia Institute of                  Technology, USA)</p>		
<p><b>IV) Energy Geo-storage</b> <a href="#">[Read more]</a></p>		
<p><b>Task leader:</b>                   Dr. Frank Wuttke                  (Kiel University,                  Germany)</p>		
<p><b>V) High Level Radioactive Waste Disposal</b> <a href="#">[Read more]</a></p>		
<p><b>Task Leader:</b>                   Dr. Antonio Gens                  (Polytechnic University                  of Catalonia, Spain).</p>		
<p><b>VI) Carbon Dioxide Geological Storage</b> <a href="#">[Read more]</a></p>		
<p><b>Task Leader:</b>                   Dr. Jean-Michel Pereira                  (Ecole des Ponts Paris                  Tech, France)</p>		

## TC Report (Con't)

### TC308 – Energy Geotechnics

VII) Others geotechnical activities related to the energy sector <a href="#">[Read more]</a>		
<p><b>Task Leader:</b> Dr. Jayantha Kodikara (Monash University, Australia)</p>		
VIII) Fundamentals of Geo-Energy <a href="#">[Read more]</a>		
<p><b>Task Leader:</b> Dr. Tomasz Hueckel (Duke University, USA)</p>		

### 3 1<sup>st</sup> International Conference on Energy Geotechnics (ICEGT-2016)

The 1<sup>st</sup> International Conference on Energy Geotechnics (ICEGT-2016) will be in Kiel (Germany) from 29<sup>th</sup> to 31<sup>st</sup> August 2016, at the University of Kiel, Germany. This will be the first conference under the guidance of the ISSMGE-TC308 on Energy Geotechnics.



More than one hundred technical papers have been accepted for presentation at the ICEGT-2016 and more than two hundred colleagues have been registered already. The conference will provide a unique forum for the exchange of innovative approaches and robust dialogue about the significant advances and critical challenges facing the areas of fundamentals, constitutive and numerical modelling, testing techniques and energy geotechnics applications. Energy geotechnics contains seven regular sessions and six minisymposia, with contributions on discrete and continuum based modelling as well as investigations based on experimental studies at various scales. The papers on discrete and continuum based modelling examine the behavior of gas hydrate sediments, cyclic and Thermo-Hydro-Mechanical (T-H-M) modelling of energy piles, non-linear behavior of energy geo-storage and geo-structures, deformation of geomaterials, modelling of borehole heat exchangers and energy walls, analysis of hydraulic fracturing and discontinuities in reservoirs, engineering problems involving gas hydrates sediments, and modelling of environmental impact of energy geotechnical processes. The technical papers on experimental investigations present small and large scale findings on particle effects, particle-particle and fluid-particle interactions, saturation and thermal effects, water retention, creep behavior, T-H-M monitoring of energy

## TC Report (Con't)

### TC308 – Energy Geotechnics

geotechnical structures, new techniques in laboratory analysis, geomechanical behavior and cyclic loading of geomaterials. Furthermore, worldwide recognized experts in the area of Energy Geotechnics have been invited to deliver Keynotes lectures.

The three main components of the conference are listed below.

#### Part I - Keynotes

**Prof. J. Carlos Santamarina.** King Abdullah University of Science and Technology, KSA  
Keynote title: *'The Energy Tera Problem: Needed Geo-centered Solutions'*

**Prof. Lyesse Laloui.** École Polytechnique Fédérale de Lausanne (EPFL), Switzerland  
Keynote title: *'Multiphysical Phenomena and Mechanisms involved with Energy Piles'*

**Prof. Itai Einav.** The University of Sydney, Australia  
Keynote title: *'An ab-initio approach to energy recovery from geothermal systems'*

**Prof. Olaf Kolditz.** Technische Universität Dresden, Germany  
Keynote title: *'Thermo-Hydro-Mechanical Chemical Processes in Fractured Porous Media: Modelling and Benchmarking Initiatives'*

**Prof. Kenichi Soga.** University of Cambridge, UK  
Keynote title: *'Potential of District-scale Geothermal Energy in Urban Cities'*

**Prof. Antonio Gens.** Universidad Politecnica de Catalunya (UPC) Barcelona, Spain  
Keynote title: *'The Evolution of Engineered Barriers for Nuclear Waste during the Transition Period'*

**Prof. Tomasz Hueckel.** Duke University, USA  
Keynote title: *'Coupled Chemo-mechanics: A Comprehensive Process Modeling for Energy Geotechnics'*

**Prof. Sebastian Bauer.** Institute of Geosciences, Kiel University, Germany  
Keynote title: *'Subsurface Energy Storage: Determining Impacts of Heat or Gas Storage in the Subsurface'*

**Dr. Klaus Wallmann, Matthias Haeckel.** IFM-GEOMAR Research Center in Kiel, Germany  
Keynote title: *'Submarine Gas Hydrate Reservoirs - Detection, Exploration, Simulation and Drilling'*

**Prof. Marcelo Sanchez.** Texas A & M University, USA  
Keynote title: *'Geomechanical and Numerical Modeling of Gas Hydrate Sediments'*

#### Part II - Regular sessions

Energy geo-storage and geo-structures  
Geotechnical challenges of energy infrastructure  
Shallow and deep subsurface geo-thermal systems  
Natural and hydraulic fractured reservoirs  
THMC behavior of geomaterials  
Numerical methods and algorithms in energy geotechnics  
Experimental studies and material design in energy geotechnics

#### Part III - Minisymposia

Geomechanical characterization and modeling of hydrate bearing sediments  
Shallow geothermal systems  
Thermo-active foundations, tunnels and earth-coupled structures  
Trends and challenges in energy geotechnical storage systems and materials  
Geotechnics risk and items for underground nuclear power plants  
Geotechnics for nuclear waste disposal

## TC Report (Con't)

### TC308 – Energy Geotechnics



We look forward to seeing you in Kiel in August 2016!!!

#### 4 Barcelona Symposium on Energy Geotechnics - SEG-2015

The TC308 organized the 1<sup>st</sup> symposium on Energy Geotechnics (SEG-2015) in Barcelona, Spain, between June 2<sup>nd</sup> and 4<sup>th</sup>, 2015. This was the first Symposium of this type organized by the TC308. The event brought together more than one hundred colleagues from different countries, including internationally recognized experts, young researchers, academics, professionals and representatives of geoengineering companies, who exchanged ideas, discussed current and future investigations and practices in the area of Energy Geotechnics.



The format of the event was singular, comprising two full days of track-sessions associated with the eight 'Task Forces' in which the TC308 has channeled its activities. Each session included:

- One Task Force 'Position Paper' delivered by the Task Force Leader.
- Two 'Invited Presentations' (delivered by recognized colleague in the area),
- A 'Technical Panel' composed by leading experts from industry and academia in the corresponding Tasks Forces.

The third day was dedicated to the presentation of the technical works submitted by delegates. In summary, a total of 7 position papers were presented, plus 23 invited lectures and 34 technical presentations. Three special issues in the Journal 'Geomechanics for the Environment and Energy' are being prepared associated with the contributions submitted to the SEG-2015. More details about these publications can be found in the section related to publications.

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### TC308 – Energy Geotechnics



Photo 1. Group Photo SEG-2015



Photo 2. Panel Session Task 5: High level radioactive waste disposal. (from left to right: Prof. Jean Vaunat, Dr. Nadia Mokni, Mr. Benoit Garitte, Prof. Pierre Delage, Prof. Antonio Gens, and Mr. Alessandro Rotta Loria)

## TC Report (Con't)

### TC308 – Energy Geotechnics



Photo 3. Position papers presentations (left: Prof. J.Carlos Santamarina, right: Prof. Antonio Gens)



Photo 4. Invited presentations (left: Prof. Pierre Delage, right: Prof. Lyesse Laloui)



Photo 5. Technical sessions

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Photo 6. Technical sessions



Photo 7. Gala dinner

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### TC308 – Energy Geotechnics

#### 5 Geotecnica ed energia

A one day workshop on Energy Geotechnics took place in Rome on April 8<sup>th</sup>, 2016. The workshop was organized by the Italian members of TC308 (Francesca Casini and Guido Musso) and by Alessio Ferrari (Switzerland) together with the Ordine degli Ingegneri of Rome, under the auspices of the Italian Geotechnical Society (AGI). It took place at Ordine degli Ingegneri site in Piazza della Repubblica, Rome.

It was the first workshop held in Italy specifically aimed at the issues of Energy Geotechnics, attended by more than 100 engineers and researchers. It was called on the evidence that geotechnical engineers nowadays are facing an increasing number of problems related to production and use of energy, whose solutions require a deep knowledge of geotechnics. These activities range from the exploitation of geothermal energy (both at depth or in energy foundations) to the production of hydrocarbons and exploitation of non-conventional energy resources, from the design of foundations for innovative solar and wind power plants to the storage of waste in deep formations, plus a number of other related themes such as CO<sub>2</sub> sequestration. All of these activities deeply benefit from the contribution of geotechnical engineers: their relevancy is high also considering the growing energy needs expected for decades to come.

The first aim of the meeting was presenting TC308 to the Italian geotechnical community, both for those who work in the academy and in the industry. Then it was also aimed at a 'cross check' between engineering needs and research contribution. Two contributions from the industry (ENEL group and Trevi) introduced some of the challenges related to energy geotechnics that Italian companies have to face daily. Contributions from engineers and academics were related to energy foundations and low enthalpy systems (6 talks), well stimulation and production from unconventional reservoirs (3 talks), heat and mass transport problems related to energy extraction from aquifers (2 talks) and energy production from wave and tidal energy (1 talk).

An intense and participated discussion took place at the end of the meeting, proving the interest that the Italian geotechnical community has nowadays on these themes.



Photo 8. Italian meeting on Energy Geotechnics - introduction to TC308 activities

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**TC308 – Energy Geotechnics**



Photo 9. Italian meeting on Energy Geotechnics - some participants



Photo 10. Italian meeting on Energy Geotechnics - Dr. Alessio Ferrari (EPFL and Università di Palermo)



Photo 11. Italian meeting on Energy Geotechnics. The organizers: (right to left Dr. Maria Elena D'Effremo (Ordine degli Ingegneri, Roma), Dr. Francesca Casini (Università Tor Vergata, Roma), Dr. Guido Musso (Politecnico di Torino) and Dr. Alessio Ferrari (EPFL Lausanne and Università di Palermo)

## TC Report (Con't)

### TC308 – Energy Geotechnics

#### 6 Other past events

The TC308 has been involved in the organization of the following sessions in ISSMGE and ASCE events:

- Co-organizer of the concurrent session 1B', 'Joint TC215-TC308 - Session Energy Geoenvironmental Technology' (8 presentations), held during the '7<sup>th</sup> International Congress on Environmental Geotechnics (7<sup>th</sup> ICEG 2014)', November 10<sup>th</sup> to 14<sup>th</sup>, 2014, Melbourne, Australia. Selected papers are considered for publication in the 'Journal of Geomechanics for Energy and the Environment'.
- Co-sponsor of two technical sessions on 'Geothermal Energy Foundations' (17 papers accepted), to be held during the 'International Foundations Congress and Equipment (IFCEE 2015)'. March 17<sup>th</sup> to 21<sup>st</sup> 2015, San Antonio, Texas, USA. <http://www.ifcee2015.com/>
- Organizer of the Track 1C 'Geo-engineering for Energy and Sustainability' held during the 'XV Pan-American Conference on Soil Mechanics and Geotechnical Engineering', 15<sup>th</sup> to 18<sup>th</sup> November 2015; Buenos Aires, Argentina. The track consisted of a Keynote Lecture a Panel Session and a number of 'Technical Sessions'. A total of 56 papers were submitted to this track on Energy Geotechnics. Selected papers by the TC308 are in-print as part of a special issue of the Journal 'Environmental Geotechnics' (more details about this aspect can be found in the Section publications).  
<http://conferencesba2015.com.ar/website/xv-panamerican-conference-on-soil-mechanics-and-geotechnical-engineering/welcomesoil/>
- Pre-Congress Course: "Multiphysics Analysis in Energy Geotechnics". In the context of the XV Pan-American Conference on Soil Mechanics and Geotechnical Engineering', 14<sup>th</sup> November 2015; Buenos Aires, Argentina. Instructors: Marcelo Sanchez and Guillermo Narsilio.
- Co-sponsor of 'The 1<sup>st</sup> International Conference on Geo-Energy & Geo-Environment', held in Hong Kong between 4<sup>th</sup> and 5<sup>th</sup> December 2015; which was being organized by the Hong Kong University of Science and Technology (HKUST). <http://gege2015.ust.hk/>

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#### 7 Summary of upcoming events

##### Organization and sponsorship of technical sessions and other events

- The TC308 is involved in the organization of three sessions related to Energy Geotechnics at the ASCE Geo-Chicago 2016 conference, to be held in Chicago, USA, 14-18 August 2016. The two sessions are: i) Geo-Energy, led by Fleur Loveridge & Guillermo Narsilio; ii) Thermal Geotechnics, led by John McCartney & Yu; and iii) Energy Geotechnics, led by Xinbao Yu & Marcelo Sánchez. A total of 20 papers will be presented in these sessions.
- Co-organizer of a Panel Session and Technical Sessions on Energy Geotechnics in the framework of the 2<sup>nd</sup> Pan American Conference on Unsaturated Soils, Dallas, Texas, November 12<sup>th</sup> - 15<sup>th</sup> 2017.
- 2<sup>nd</sup> SEG: the TC308 has started the process to select the host for the 'Second Symposium on Energy Geotechnics' (tentative date: mid 2018).
- 2<sup>nd</sup> ICEGT: the TC308 has started the process to select the host for the 'Second International Conference on Energy Geotechnics' (tentative date: mid 2020).

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#### 8 Publications organized by the TC308

##### Journal Publications

- John McCartney, Marcelo Sánchez and Ingrid Tomac have recently published a review paper aimed at identifying the main areas of research in Energy Geotechnics and the associated key contributions. The paper is entitled "Energy Geotechnics: Advances in Subsurface Energy Recovery, Storage, Exchange, and Waste Management". It is available at  
<http://www.sciencedirect.com/science/article/pii/S0266352X16000045>

## TC Report (Con't)

### TC308 – Energy Geotechnics

- The themed issue of the Journal Geomechanics for Energy and the Environment 'SEG-2015-Part I', presents papers selected by the TC308 from abstracts submitted to the Symposium on Energy Geotechnics (SEG-2015) held in Barcelona, Spain, between June 2nd and 4th, 2015. This special issue consists of eight papers selected from the invited and technical presentations after a Journal peer-review process. Part I of the special issue is now published and can be found online at: <http://www.sciencedirect.com/science/journal/23523808/6>.
- The themed issue of the Journal Geomechanics for Energy and the Environment 'SEG-2015-Part II' is a continuation of the Part I described above and will present (around) 8 more papers selected by the TC308 from abstracts submitted to the SEG-2015. This special issue is at advanced stages of the peer-reviewing process and it is expected to be published by the end of this year.
- The themed issue of the Journal Geomechanics for Energy and the Environment 'Position Papers on Energy Geotechnics' will contain (around) 8 position papers associated with the TC308 Task Forces. These position papers were presented at the SEG-2015. This special issue is expected to be published earlier next year.
- The themed issue of the Journal Environmental Geotechnics 'XV Pan-American Conference: Selected papers on Energy Geotechnics', presents 8 peer-review papers (following typical journal guidelines) submitted to the Sessions on Energy Geotechnics organized by the TC308 at the XV Pan-American Conference held in Buenos Aires, Nov. 2015. These papers are extended versions of the ones submitted to the Conference. This special issue is currently in-print.

#### Conference Publications

All the papers accepted at the 1<sup>st</sup> ICEGT will be published in a Proceeding by CRC Press Balkema - Taylor & Francis Group. Editors: Frank Wuttke, Sebastian Bauer and Marcelo Sánchez (in-print).

## Conference Report

### The 25<sup>th</sup> European Young Geotechnical Engineers Conference



*Proud to be* **GEOTECHNICAL ENGINEER**

The 25<sup>th</sup> European Young Geotechnical Engineers Conference was organized by the Romanian Society for Geotechnical and Foundation Engineering with the support of the Technical University of Civil Engineering Bucharest, Department of Geotechnical and Foundation Engineering under the auspices of the International Society for Soil Mechanics and Geotechnical Engineering.

For young participants, *Proud to be* **GEOTECHNICAL ENGINEER**, is not only the motto of the conference, it is the expression of a future career, full of challenges and also achievements. All the senior participants at the conference, with many years of experience in the field, stated that they are proud to be geotechnical engineers!

The conference took place in Sibiu, also known as Hermannstadt, a beautiful old city from Transylvania, the European Capital of Culture for the year 2007, Europe's 8<sup>th</sup> most idyllic place to live (ranked by Forbes). The conference was held in Hotel Ibis Sibiu, in the very center of the city. The accommodation for the delegates, the welcome reception, the breakfasts, the lunches and the conference sessions took place in the same location.

The Organizing Committee sent invitation on 16<sup>th</sup> of November 2015 to all the European Member Societies to nominate delegates for the 25<sup>th</sup> European Young Geotechnical Engineers Conference. Most of the European Member Societies sent a positive answer, some explained that no young researchers are interested in participating at the conference, but some didn't send any response. The Scientific Committee reviewed and accepted for publication 46 papers sent by representatives of European Member Societies. The proceedings contain also three keynote lectures consisting in a total number of 434 pages.

The conference was attended by 68 participants: 49 young delegates representing 24 European Member Societies of ISSMGE, 4 keynote lecturers, 4 invited lecturers (sponsors), members of the organizing and scientific committees.

The conference was organized following the "Guidelines for organizing Young Geotechnical Engineers' Conferences" published by the International Society for Soil Mechanics and Geotechnical Engineering in November 2007. There is one single exception from these guidelines: "It is important that each delegate produces a paper for which they are the sole author" (ISSMGE, 2007) but the Organizing Committee accepted papers with more than one author, with the condition that all the authors must be under 35 years of age at the completion of conference.

The day of 21<sup>st</sup> of June represented the moment of meeting each other during the welcome reception. The conference was organized in 8 sessions distributed on 22<sup>nd</sup> and 23<sup>rd</sup> of June:

- In-situ and Laboratory Testing
- Researches in Geotechnical Engineering
- Underground Structures
- Retaining Structures
- Numerical/Physical Modeling
- Slope Stability and Landslides
- Soil Dynamics
- Geosynthetics



Photo 1. Participants at the conference sessions

## Conference Report (Con't)

### The 25<sup>th</sup> European Young Geotechnical Engineers Conference

Each session was started by a keynote or invited lecture. The following keynote lectures have been delivered:

- General presentation of Eurocode 7 on Geotechnical design by **Roger Frank** - ISSMGE President, **École Nationale des Ponts et Chaussées**
- Difficult foundation conditions in Romania by **Ernest Olinic**, **Technical University of Civil Engineering Bucharest**
- Modern Design of Landfill Liners by **Mario Manassero**, **Politecnico di Torino**
- Lessons from the failure of a tailings dam by **Antonio Gens**- ISSMGE Vice-President for Europe, **Universitat Politècnica de Catalunya**

The following invited lectures have been delivered by the sponsors of the conference:

- SOLETANCHE BACHY Romania by **Lorand Sata**, **SOLETANCHE BACHY Romania**
- Staggered anchors - Züblin Romania performs step anchors in Romania by **Adrian Tudorache**, **ZUBLIN Romania**
- Influence of Soil Improvement on Seismic Ground Response by **Laurentiu Floroui**, **KELLER Geotechnica**
- An overview of pioneering projects with geosynthetic reinforcement over 20 years by **Dimiter Alexiew**, **HUESKER**

The lectures have been followed by 10 minutes presentations delivered by young participants. In total, 44 papers have been presented from a total of 46 (two young researchers who published papers couldn't participate at the conference).



Photo 2. Keynote Lecture: Prof. Roger FRANK

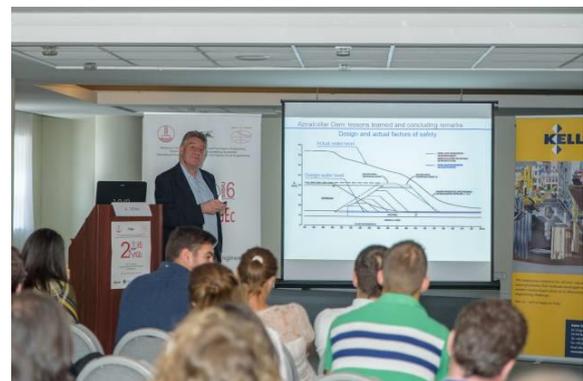


Photo 3. Keynote lecture: Prof. Antonio GENS



Photo 4. Keynote Lecture: Prof. Mario MANASSERO



Photo 5. Keynote Lecture: Assoc. Prof. Ernest OLINIC

## Conference Report (Con't)

### The 25<sup>th</sup> European Young Geotechnical Engineers Conference



Photo 6. Welcome reception

The dinners from 22<sup>nd</sup> and 23<sup>rd</sup> of June were organized at restaurants in Sibiu in places with strong Romanian traditional accents.



Photo 7. The dinner from 22<sup>nd</sup> of June at Restaurant La Dobrun



Photo 8. A walk in the village museum Astra Romana



Photo 9. The dinner from 23<sup>rd</sup> of June at Hanul din Tulghes

## Conference Report (Con't)

### The 25<sup>th</sup> European Young Geotechnical Engineers Conference

The technical visit was on Transfagarasan, one of the most beautiful roads in the world, with a length of approximate 90 km, built in 1970 - 1974. The road crosses the Carpathian Mountains in the highest section, the Fagaras Mountains, connecting the historic regions Transylvania and Wallachia.



Photo 10. A part of the participants at the technical visit, many of them wearing the t-shirt of the conference

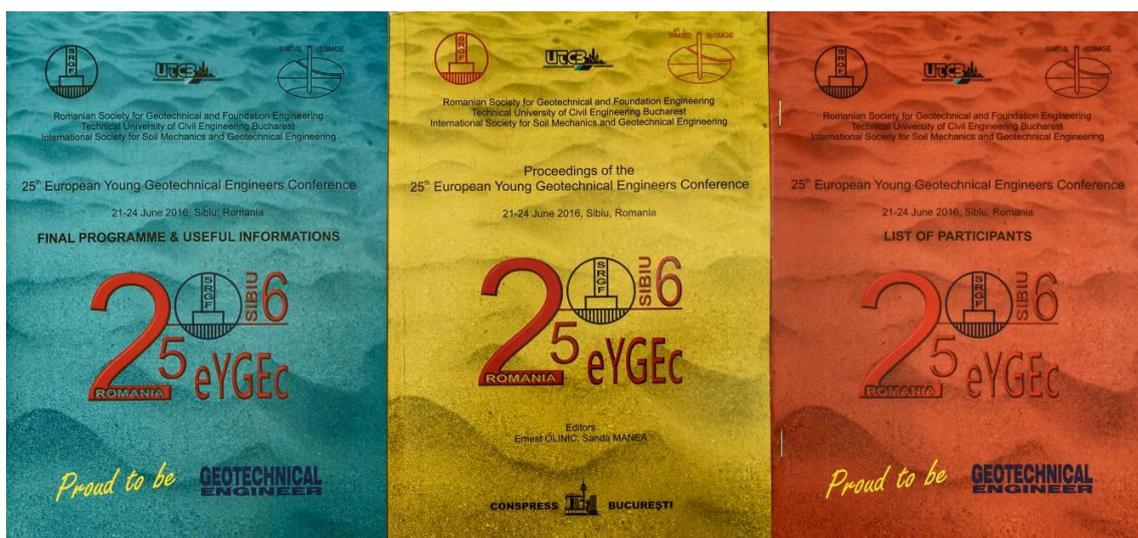


Photo 11. The final programme, proceedings and list of participants forming the national flag of Romania



Photo 12. The Organizing Committee from left to right: Daniel MANOLI, Catalin BURLACU, Nicoleta-Maria ILIES, Ernest OLINIC (Bogdan-lancu TEODORU - not in the picture)

## Conference Report (Con't)

### The 25<sup>th</sup> European Young Geotechnical Engineers Conference

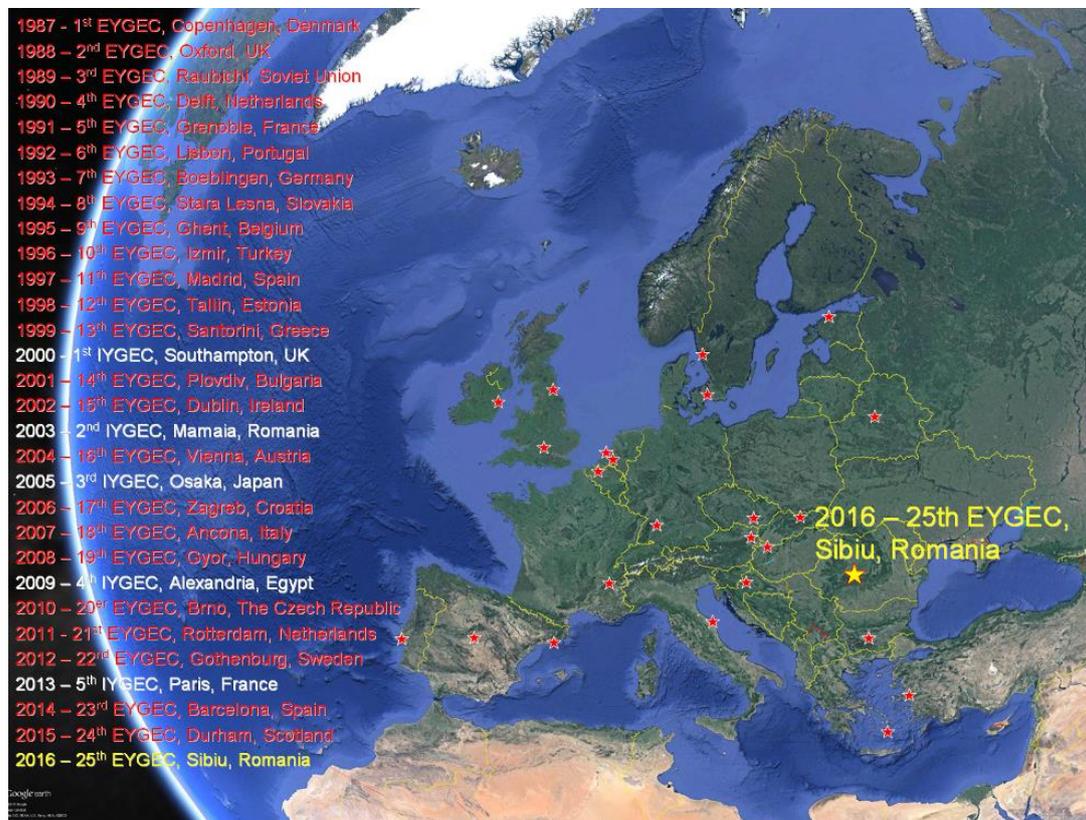


Figure 1. The map of cities that hosted an European Young Geotechnical Engineers Conference

The Conference Chairperson is proud for placing the 25<sup>th</sup> star on the EYGEC map in the position of Sibiu, Romania and is very grateful to the International Society for Soil Mechanics and Geotechnical Engineering for the opportunity to organize a conference, technically very interesting and socially very pleasant. The organizers are very grateful for the financial support offered by ISSMGE, Keller, Soletanche Bachy, Huesker, Zublin.

ORGANIZING COMMITTEE	SCIENTIFIC COMMITTEE
Ernest OLINIC - Conference Chairperson <i>Technical University of Civil Engineering Bucharest</i>	Sanda MANEA - Chairperson <i>Technical University of Civil Engineering Bucharest</i>
Nicoleta - Maria ILIES <i>Technical University of Cluj - Napoca</i>	Ernest OLINIC <i>Technical University of Civil Engineering Bucharest</i>
Iancu - Bogdan TEODORU <i>"Gh. Asachi" Technical University of Iasi</i>	Loretta BATALI <i>Technical University of Civil Engineering Bucharest</i>
Daniel MANOLI <i>Technical University of Civil Engineering Bucharest</i>	Nicoleta - Maria ILIES <i>Technical University of Cluj - Napoca</i>
Catalin BURLACU <i>Technical University of Civil Engineering Bucharest</i>	Irina LUNGU <i>"Gh. Asachi" Technical University of Iasi</i>
	Luiza ROMAN <i>"Politehnica" University of Timisoara</i>

## Conference Report (Con't)

### The 25<sup>th</sup> European Young Geotechnical Engineers Conference

#### SPONSORS



*Organising committee of 25EYGEC*

## ISSMGE Foundation report

The conference, 25<sup>th</sup> European Young Geotechnical Engineers Conference (EYGEC 2016) was organized by the Romanian Society for Geotechnical Engineering Technical University of Civil Engineering Bucharest, the International Society of Soil Mechanics and Geotechnical Engineering. The organizing committee consisted of: Ernest OLINIC, Nicoleta -Maria ILIES, Daniel MANOLI, Bogdan TEODORU, Daniel MANOLI and Catalin BURLACU. The scientific committee consisted of Sanda MANEA, Ernest OLINIC, Irina LUNGU, Luiza ROMAN, Nicoleta -Maria ILIES, Loretta BATALI.

The conference was attended by 53 invited delegates from 23 European countries. Former USSR countries were represented by Ukraine delegates only, thanks to the financial support provided by the ISSMGE Foundation. A Ukrainian delegate, Sergii Poklonskyi, has obtained a financial support as well, but he was not able to attend to Sibiu. He also thanks to the ISSMGE Foundation and RoSGTFE for the possibility to publish his paper in the conference proceedings.

The conference was held on 22<sup>nd</sup> and 23<sup>rd</sup> June at the Hotel Ibis, Sibiu, Romania. The conference was divided into 8 sessions; 4 sessions a day. Each session lasted for 90-120 minutes with breaks of 30-minutes and 60 minutes for lunch. In general, except the introductory and concluding parts, there was a 15-30 minute presentation by the Organizing Committee, a 30-minute lecture from sponsors and 53 presentations from delegates. Each delegate was given 8 minutes to report and 5 minutes for discussion. The official conference language was English. There were 53 delegates who gave oral presentations at the conference and these presentations were divided into several themed sections of Geotechnics: *in-situ and laboratory tests; researches in geotechnical engineering; underground structures; retaining structures; numerical/physical modeling; slope stability and landslides; soil dynamics; geosynthetics.*

All presentations were very interesting. I especially like working with video experiments. Among the best in my opinion were the presentations given by:

- Helen P. DUNNE from the University of Oxford
- Nejla YILDIZ from Turkey
- David KOPPMAN from Germany

The title of my presentation was "Barrettes under negative friction of soil surrounding".



Figure 1. During my presentation

Iryna Mieshkova  
Kyiv State Research Institute of Buildings Constructions city

**Hot News****Journal of Earth Engineering****Journal Of  
Earth Engineering**

Recently, many countries have placed focus on developing their infrastructures such as roads, railways, subways, airports, harbors and dams. The need for dedicated journals to this field is more than ever. JEE is hopeful to provide a forum to share unpublished studies and researches for experts in the field of geomechanics. Audiences are any scientists, experts and highly educated students which they research and work on geomechanics problems in geotechnical engineering, petroleum, geological and mining engineering.

JEE is a peer-reviewed open access journal that publishes high quality research works both practical and theoretical approaches. It has four types of article which they are research paper, review paper, technical note and discussions. The journal is assisted by highly qualified and expert editorial committee around the world. There is no charge for submission and publishing to JEE. For further information contact us ([www.journalee.org](http://www.journalee.org)).

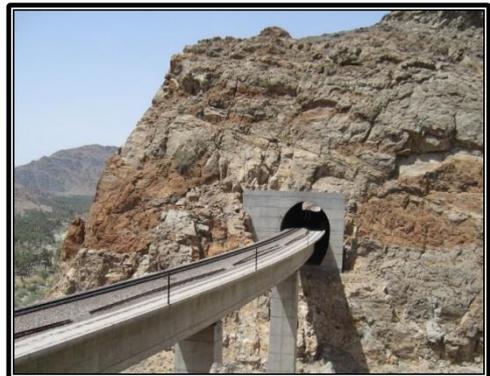
**Topics:**

- Advances in rock mechanics, tunneling, mining, dams, rock mass classification, rock mass strength, rock slopes stability, rock fall, blasting, ground vibrations, rock fracture mechanics, foundations on rock, drilling shafts, subsidence, rock reinforcement, excavation monitoring, rock mechanics in petroleum engineering, old stone structure problems, seepage and hydrogeological engineering, geological engineering.
- Advances in soil mechanics, tunneling in soft ground, soil strength, soil slope stability and landslides, hydraulic conductivity, piles, shields, retaining walls, soil reinforcement, foundations, settlement, deep excavating in soils, soil improvement, soil vibrations, soil structures monitoring, soil-structure interaction problems, earthquake engineering in geotechnics, large displacement problems.
- Numerical modeling in geomechanics, physical modeling, mathematical approaches in soil and rock mechanics, laboratory tests, field tests.

We thank you for your interest and subscription to JEE and ask for your continued support.



ISSN: 2476-4825



## Event Diary

### ISSMGE EVENTS

Please refer to the specific conference website for full details and latest information.

#### 2016

##### 1<sup>st</sup> International Conference on Energy Geotechnics ICEGT 2016

Date: Monday 29 August 2016 - Wednesday 31 August 2016

Location: Auditorium Maximum (Audimax) of Kiel University, Kiel, Germany

Language: English

Organizer: ISSMGE TC308 on Energy Geotechnics

Contact person: ICEGT 2016 Secretariat

Address: Ludewig Meyn Str. 10, 24118, Kiel, Germany

Phone: +49 - (0) 431 - 880 1976

Fax: +49 - (0) 431 - 880 4376

E-mail: [secretary@icegt-2016.de](mailto:secretary@icegt-2016.de)

Website: <http://www.iceg-2016.de/>

##### 3<sup>rd</sup> ICTG International Conference on Transportation Geotechnics

Date: Sunday 04 September 2016 - Wednesday 07 September 2016

Location: Vila Flor Cultural Centre and University of Minho, Guimaraes, Portugal

Language: English

Organizer: Portuguese Geotechnical Society and University of Minho

Contact person: Prof. A. Gomes Correia (Chair)

Address: University of Minho, School of Engineering, 4800-058, Guimarães, Portugal

Phone: +351253510200

Fax: +351253510217

E-mail: [agc@civil.uminho.pt](mailto:agc@civil.uminho.pt)

Website: <http://www.webforum.com/tc3>

##### 5<sup>th</sup> International Conference on Geotechnical and Geophysical Site Characterisation (ISC'5)

Date: Monday 05 September 2016 - Friday 09 September 2016

Location: QT Hotel, Gold Coast, QLD, Australia

Language: English

Organizer: Leishman Associates

Address: 113 Harrington St, 7000, Hobart, TAS, Australia

Phone: 03 6234 7844

E-mail: [hannah@laevents.com.au](mailto:hannah@laevents.com.au)

Website: <http://www.isc5.com.au>

##### 8<sup>th</sup> International Conference on Scour and Erosion,

Date: Monday 12 September 2016 - Wednesday 15 September 2016

Location: University of Oxford Mathematical Institute, Oxford, United Kingdom

Language: English

Organizer: HR Wallingford

Contact person: Sarah Moxon

Address: HR Wallingford, Howbery Park, OX10 8BA, Wallingford, Oxfordshire, United Kingdom

Phone: +44 (0)1491 835381

E-mail: [icse2016@hrwallingford.com](mailto:icse2016@hrwallingford.com)

Website: [www.icse2016.com/](http://www.icse2016.com/)

## Event Diary (Con't)

### 3<sup>rd</sup> European Conference on Unsaturated Soils - Paris 2016

Date: Monday 12 September 2016 - Wednesday 14 September 2016

Location: Ecole des ponts ParisTech, Marne la Vallée, France

Language: English

Organizer: Ecole des ponts

Contact person: Severine Beaunier

Address: PFC, Maison des ponts, 15 Rue de la Fontaine au Roi ,75011 Paris, France

Phone: 33144582700

E-mail: [severine.beaunier@enpc.fr](mailto:severine.beaunier@enpc.fr)

Website: <http://eunsat2016.sciencesconf.org/>

### 13<sup>th</sup> Baltic States Geotechnical Conference

Date: Thursday 15 September 2016 - Saturday 17 September 2016

Location: Vilnius University, Vilnius, Lithuania

Language: English

Organizer: Baltic Sea states Geotechnical Societies / Main organizer Lithuanian Geotechnical Society

Contact person: Danutė Sližytė

Address: Saulėtekio ave. 15-510, LT-10224, Vilnius, Lithuania

Phone: +37068690044

Fax: +37052500604

E-mail: [danute.slizyte@vgtu.lt](mailto:danute.slizyte@vgtu.lt)

Website: <http://www.13bsgc.lt>

### International Geotechnical Engineering Conference on Sustainability in Geotechnical Engineering Practices and Related Urban Issues

Date: Friday 23 September 2016 - Saturday 24 September 2016

Location: Ramada Powai Hotel and Convention Centre, Saki Vihar Road, Powai, Mumbai Maharashtra, India

Language: English

Organizer: Indian Geotechnical Society Mumbai Chapter with Indian Geotechnical Society (IGS) and ISSMGE

Contact person: Prof. Deepankar Choudhury

Address: Professor and Organising Secretary, Department of Civil Engineering, IIT Bombay, Powai, 400076 Mumbai, Maharashtra, India

Phone: +91-22-25767335

Fax: +91-22-25767302

E-mail: [igsmumbai@gmail.com](mailto:igsmumbai@gmail.com)

Website: <http://www.igsmumbaichapter.in/>

### 69<sup>th</sup> Annual Canadian Geotechnical Conference - GeoVancouver2016

Date: Sunday 02 October 2016 - Wednesday 05 October 2016

Location: Westin Bayshore Hotel, Vancouver, British Columbia, Canada

Language: English and French

Organizer: The Canadian Geotechnical Society (see: [www.cgs.ca](http://www.cgs.ca))

Contact person: Dr. Mustapha Zergoun, P.Eng., P.E.

Address: Suite 900, 1281 West Georgia Street, V6E 3J7, Vancouver, British Columbia, Canada

Phone: 604-684-4384

Fax: 604-684-5124

E-mail: [mzergoun@thurber.ca](mailto:mzergoun@thurber.ca)

Website: <http://www.geovancouver2016.com>

## Event Diary (Con't)

### GEO-EXPO 2016 Scientific and Expert Conference

Date: Friday 07 October 2016 - Saturday 08 October 2016

Location: Faculty of Architecture, Civil Engineering and Geodesy, University of Banja Luka, Banja Luka, Bosnia and Herzegovina

Language: English, Bosnian, Croatian, Serbian

Organizer: Geotechnical Society of Bosnia and Herzegovina

Contact person: Prof. Sabid Zekan

Address: Univerzitetska 2, 75000 Tuzla, Bosnia and Herzegovina

Phone: + 387 61 56 22 77

Fax: + 387 35 32 05 70

E-mail: [geotehnika@geotehnika.ba](mailto:geotehnika@geotehnika.ba), [info@geotehnika.ba](mailto:info@geotehnika.ba)

Website: <http://www.geotehnika.ba>

### 9<sup>th</sup> All-Ukrainian Scientific-Technical Conference “Soil mechanics, geotechnics and foundation engineering”: “Geotechnical innovations and implementation of Eurocodes in Ukraine”

Date: Tuesday 11 October 2016 - Thursday 13 October 2016

Location: Dnieper state academy of construction and architecture, Dnipropetrovsk, Ukraine

Language: English, Ukrainian, Russia

Organizer: Ukrainian society of soil mechanics, geotechnics and foundation engineering

Address: SE NDIBK, 5/2 Preobrazhenska street, 03037, Kiev-37, Ukraine

Phone: (056) 247-08-88

E-mail: [iepi@pgasa.dp.ua](mailto:iepi@pgasa.dp.ua)

Website: [www.niisc.com](http://www.niisc.com) (section: Conferences)

### XVIII Brazilian Conference on Soil Mechanics and Geotechnical Engineering - COBRAMSEG 2016

Date: Wednesday 19 October 2016 - Saturday 22 October 2016

Location: Minascentro, Belo Horizonte, MG, Brazil

Language: Portuguese and English

Organizer: ABMS - Brazilian Society for Soils Mechanics and Geotechnical Engineering

E-mail: [contato@cobramseg2016.com.br](mailto:contato@cobramseg2016.com.br)

Website: <http://www.cobramseg2016.com.br/>

### SFGE 2016 - Shaping the Future of Geotechnical Education - International Conference on Geotechnical Education

Date: Thursday 20 October 2016 - Saturday 22 October 2016

Location: Minascentro, Belo Horizonte, MG, Brazil

Language: English

Organizer: ISSMGE TC306 and ABMS - Brazilian Society for Soil Mechanics and Geotechnical Engineering

Contact person: Michele Calvello

E-mail: [sfge2016@cobramseg2016.com.br](mailto:sfge2016@cobramseg2016.com.br) / [michele.calvello@gmail.com](mailto:michele.calvello@gmail.com)

Website: <http://cobramseg2016.com.br/index.php/sfge-sobre/?lang=en>

### V South American Young Geotechnical Engineers Conference - SAYGEC/GEOJOVEM 2016

Date: Thursday 20 October 2016 - Saturday 22 October 2016

Location: Minascentro, Belo Horizonte, MG, Brazil

Language: Portuguese, Spanish, English

Organizer: ABMS - Brazilian Society for Soil Mechanics and Geotechnical Engineering

Contact person: Prof A. Terezinha Esposito

E-mail: [geojovem@cobramseg2016.com.br](mailto:geojovem@cobramseg2016.com.br)

Website: <http://www.cobramseg2016.com.br>

## Event Diary (Con't)

### 11<sup>th</sup> ANZ Young Geotechnical Professionals Conference (11YGPC)

Date: Tuesday 25 October 2016 - Friday 28 October 2016

Location: Queenstown, New Zealand

Language: English

Organizer: NZGS

Contact person: Frances Neeson

E-mail: [11ygpc@gmail.com](mailto:11ygpc@gmail.com)

Website: [http://www.nzgs.org/resources/pdfs/YGP\\_11Queens2016formsv1.pdf](http://www.nzgs.org/resources/pdfs/YGP_11Queens2016formsv1.pdf)

### XXIII CAMSIG - Argentinian Congress on Soil Mechanics and Geotechnical Engineering

Date: Wednesday 09 November 2016 - Friday 11 November 2016

Location: Paraninfo de la Universidad Nacional del Litoral, Santa Fé, Argentina

Language: Spanish

Organizer: SAIG

Contact person: Paraninfo UNL Bv

Address: Pellegrini 2750, Santa Fe, Argentina

Phone: +54 (0342) 4602390 / 4601579, interno 2200 (16 a 20 h)

E-mail: [camsig2016@frsf.utn.edu.ar](mailto:camsig2016@frsf.utn.edu.ar)

Website: <http://fich.unl.edu.ar/camsig2016>

### 5<sup>th</sup> International Conference on Geotechnical Engineering and Soil Mechanics

Date: Monday 14 November 2016 - Wednesday 16 November 2016

Location: Tehran, Iran

Organizer: International Conference on Geotechnical Engineering and Soil Mechanics

Contact person: 009888931328

Address: Unit2, No 14, Eftekharnia Alley, Larestan St, Motahari Ave, 1595914911 Tehran, Iran

Phone: 9888931507

Fax: 9888931275

E-mail: [info@igs.ir](mailto:info@igs.ir)

Website: [www.igs.ir](http://www.igs.ir)

### Geotec Hanoi 2016

Date: Thursday 24 November 2016 - Friday 25 November 2016

Location: JW Marriott Hotel Hanoi, No 8 Do Duc Duc Road, Me Tri Ward, South Tu Liem District, Hanoi, Vietnam

Language: English

Organizer: FECON, VSSMGE, and JGS

Contact person: GEOTEC HANOI 2016 Secretariat

Address: FECON Corp, 15th Floor, CEO Tower, Lot HH2-1 Urban Me Tri Ha, Pham Hung Street, Ward Me Tri, Nam Tu Liem District, Hanoi, Vietnam

Phone: +84 4 6269.0481 / 82

Fax: +84 4 6269 0484

E-mail: [secretariat@geotechn.vn](mailto:secretariat@geotechn.vn)

Website: [www.geotechn.vn](http://www.geotechn.vn)

## Event Diary (Con't)

### IX Chilean Congress of Geotechnics

Date: Monday 05 December 2016 - Wednesday 07 December 2016  
Location: Universidad Austral de Chile, Valdivia, XIV Región de Los Ríos, Chile  
Language: Spanish - English  
Organizer: SOCHIGE  
Contact person: Macarena Tugas  
Address: San Isidro 53, Santiago, Santiago, Chile  
Phone: +56994253193  
E-mail: [directorio@sochige.cl](mailto:directorio@sochige.cl)  
Website: <http://www.congresosochige.cl>

### International Conference on Forensic Geotechnical Engineering

Date: Thursday 08 December 2016 - Saturday 10 December 2016  
Location: Satish Dhawan Auditorium, Bangalore, Karnataka, India  
Language: English  
Organizer: ISSMGE TC 302  
Contact person: Dr. Anbazhagan  
Address: Indian Institute of Science, 560012, Bangalore, Karnataka, India  
Phone: 00918022932467  
E-mail: [anbu@civil.iisc.ernet.in](mailto:anbu@civil.iisc.ernet.in)

## 2017

### Advances in Laboratory Testing and Modelling of Soils and Shales

Date: Wednesday 18 January 2017 - Friday 20 January 2017  
Location: Swiss Alps, Switzerland  
Language: English  
Organizer: Prof. Lyesse Laloui and Prof. Alessio Ferrari  
Contact person: Ms Valentina Favero  
Address: EPFL-ENAC-IIC-LMS, Station 18, CH-1015, Lausanne, Switzerland  
Phone: +41 (0)21 693 23 13  
E-mail: [valentina.favero@epfl.ch](mailto:valentina.favero@epfl.ch)  
Website: <http://atmss.epfl.ch>

### International Conference on New Challenges In Geotechnical Engineering, ICNCGE-2017

Date: Monday 23 January 2017  
Location: FAST National University, Lahore, Punjab, Pakistan  
Language: English  
Organizer: Pakistan Geotechnical Engineering Society - PGES  
Contact person: Syed Badar Ul Hussnain  
Address: NESPAK House, 1-C, Block N, Model Town Lahore-Pakistan, 54700, Lahore, Punjab, Pakistan  
Phone: +92 42 99090325  
Fax: +92 42 99231950  
E-mail: [icncge2017@gmail.com](mailto:icncge2017@gmail.com)  
Website: <http://www.pges-pak.org/home/icncge-2017>

## Event Diary (Con't)

### 9<sup>th</sup> International Symposium on Geotechnical Aspects of Underground Construction in Soft Ground, IS - São Paulo 2017

Date: Tuesday 04 April 2017 - Thursday 06 April 2017

Location: Centro de Convenções Rebouças, São Paulo, SP, Brazil

Language: English

Organizer: Brazilian Association for Soil Mechanics and Geotechnical Engineering (ABMS) and the Brazilian Tunnelling Committee (CBT)

Contact person: MCI São Paulo

Address: Rua George Ohm, 230 - Torre A, 19º Andar, 04576-020, São Paulo, SP, Brazil

Phone: 55 11 3056-6000

Fax: 55 11 3056-6000

E-mail: [atendimento@mci-group.com](mailto:atendimento@mci-group.com)

Website: <http://www.is-saopaulo.com>

### BCRRA 2017 - Tenth International Conference on the Bearing Capacity of Roads, Railways and Airfields.

Date: Wednesday 28 June 2017 - Friday 30 June 2017

Location: ATHENS, Greece

Language: English

Local Organizer: National Technical University of Athens (NTUA)

Contact person: Prof. Andreas Loizos

Address: 5, Iroon Polytechniou str., 15773, ATHENS, Greece

Phone: + 30 210 7721279

Fax: + 30 210 7724254

E-mail: [aloizos@central.ntua.gr](mailto:aloizos@central.ntua.gr)

Website: <http://www.bcrra2017.com/>

### GeoMEast 2017

Date: Saturday 15 July 2017 - Wednesday 19 July 2017

Location: Sharm El-Sheikh, Egypt

Language: English

Organizer: The Egyptian Housing and Building Research Center (HBRC) in cooperation with the Soil-Structure Interaction Group in Egypt (SSIGE)

Contact person: Hany Farouk Shehata

Address: Tower C, Maamora Towers, 7th District, Nasr City, 11727, Cairo, Egypt

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E-mail: [hanyfarouk808@gmail.com](mailto:hanyfarouk808@gmail.com)

Website: <http://www.geomeast2017.org/>

### PBD-III Vancouver 2017 - The 3<sup>rd</sup> International Conference on Performance Based Design in Earthquake Geotechnical Engineering

Date: Sunday 16 July 2017 - Wednesday 19 July 2017

Location: Westin Bayshore Hotel (<http://www.westinbayshore.com/>) Vancouver, British Columbia, Canada

Language: English

Organizer: TC203 (Earthquakes)

Website: <http://pbdiivancouver.com/>

## Event Diary (Con't)

### 2<sup>nd</sup> International Symposium on Coupled Phenomena in Environmental Geotechnics (CPEG2)

Date: Wednesday 06 September 2017 - Friday 08 September 2017

Location: Faculty of Engineering, University of Leeds, Leeds, W. Yorks, United Kingdom

Language: English

Organizer: CPD, Conference & Events Unit, Faculty of Engineering, University of Leeds, LEEDS, LS2 9JT, UK

Contact person CPD, Conference & Events Unit

Address: Faculty of Engineering, University of Leeds, LS2 9JT, Leeds, W. Yorks, United Kingdom

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

E-mail: [CPEG2@leeds.ac.uk](mailto:CPEG2@leeds.ac.uk)

Website: <http://tinyurl.com/cpeg2017>

### ICSMGE 2017 - 19<sup>th</sup> International Conference on Soil Mechanics and Geotechnical Engineering, Seoul

Date: Sunday 17 September 2017 - Thursday 21 September 2017

Location: Coex Convention Center, Seoul, Korea

Language: English and French

Organizer: Organising Committee of ICSMGE 2017

Contact person: Ms. Soi LEE

Address: 4F, SUNGJI Building, 192, Bangbae-ro, Seocho-gu, 137-835, Seoul, Republic of Korea

Phone: +82-2-6288-6347

Fax: +82-2-6288-6399

E-mail: [secretariat@icsmge2017.org](mailto:secretariat@icsmge2017.org)

Website: <http://www.icsmge2017.org>

## 2018

### 4<sup>th</sup> International Symposium on Cone Penetration Testing (CPT'18)

Date: Thursday 21 June 2018 - Friday 22 June 2018

Location: Delft University of Technology (TUD), Delft, Netherlands,

Language: English

Organizer: Delft University of Technology (endorsed by TC102)

Contact person: Prof. Michael Hicks, Dr. Federico Pisanò and Ir. Joek Peuchen

Address: Faculty of Civil Engineering and Geosciences, Section of Geo-Engineering, Building 23, Stevinweg 1, 2628 CN Delft, The Netherlands

Phone: +31 70 31 11299

E-mail: [info@cpt18.org](mailto:info@cpt18.org)

Website: <http://www.cpt18.org>

### The 7<sup>th</sup> International Conference on Unsaturated Soils (UNSAT2018)

Date: Friday 03 August 2018 - Sunday 05 August 2018

Location: The Hong Kong University of Science and Technology (HKUST), Hong Kong, China

Language: English

Organizer: The Hong Kong University of Science and Technology (HKUST)

Contact persons: Prof. Charles W. W. Ng (Chair), Miss Shirley Tse (Administrative Secretary) or Dr Anthony Leung (Technical Secretary)

Address: Geotechnical Centrifuge Facility, The Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, HKSAR, China

Phone: (852) 2358-0216

Fax: (852) 2243-0040

E-mail: [unsat2018@ust.hk](mailto:unsat2018@ust.hk)

Website: <http://www.unsat2018.org>

**Event Diary (Con't)****2019****7 ICEGE 2019 - International Conference on Earthquake Geotechnical Engineering**

Date: Monday 17 June 2019 - Thursday 20 June 2019

Location: Rome, Italy

Language: English

Organizer: TC203 and AGI (Italian Geotechnical Society)

Contact person: Susanna Antonielli

Address: AGI - Viale dell' Università 11, 00185, Roma, Italy

Phone: +39 06 4465569

Fax: +39 06 44361035

E-mail: [agi@associazionegeotecnica.it](mailto:agi@associazionegeotecnica.it)

**ISDCG 2019 - 7<sup>th</sup> International Symposium on Deformation Characteristics of Geomaterials**

Date: Wednesday 26 June 2019 - Friday 28 June 2019

Location: Technology and Innovation Centre (TIC) of the University of Strathclyde, Scotland, UK,

Language: English

Organizer: TC101

Website: *in construction*

**ECSMGE 2019 - XVII European Conference on Soil Mechanics and Geotechnical Engineering**

Date: Sunday 01 September 2019 - Friday 06 September 2019

Location: Harpa Conference Centre Reykjavik, Iceland

Language: English

Organizer: The Icelandic Geotechnical Society

Contact person: Haraldur Sigursteinsson

Address: Vegagerdin, Borgartún 7, IS-109, Reykjavik, Iceland

Phone: +354 522 1236

E-mail: [has@road.is](mailto:has@road.is)

Website: <http://www.ecsmge-2019.com>

**XVI Asian Regional Conference on Soil Mechanics and Geotechnical Engineering**

Date: Monday 21 October 2019 - Friday 25 October 2019

Location: Taipei, China

**XVI Panamerican Conference on Soil Mechanics and Geotechnical Engineering**

Date: Monday 18 November 2019 - Friday 22 November 2019

Location: Cancun, Quintana Roo, Mexico

Organizer: SMIG

Phone: +(52) 1 55 5677-3730, +(52) 1 55 5679 3676

E-mail: [support@panamerican2019mexico.com](mailto:support@panamerican2019mexico.com)

Website: <http://panamerican2019mexico.com>

**Event Diary (Con't)****NON-ISSMGE SPONSORED EVENTS****2016****Advancing Experimental Geomechanics**

Date: Monday 31 October 2016 - Wednesday 02 November 2016

Location: Mercure Resort Hunter Valley Gardens, Pokolbin, NSW, Australia

Language: English

Organizer: Benjy Marks

Contact person: Benjy Marks

Address: Civil Engineering Building, J05, 2006, The University of Sydney, NSW, Australia

Phone: +61 02 9351 2146

E-mail: [benjy.marks@sydney.edu.au](mailto:benjy.marks@sydney.edu.au)

Website: <http://sydney.edu.au/engineering/civil/research/scigem/workshops/aeg2016.shtml>

**International Seminar on Roads, Bridges and Tunnels**

Date: Friday 18 November 2016 - Thursday 24 November 2016

Location: Aristotle University of Thessaloniki (AUTH), Thessaloniki, Greece

Language: English

Organizer: School of Civil Engineering along with the Highway Engineering Laboratory of the Aristotle University of Thessaloniki (AUTH)

Contact person Mrs. D. Gatoula: and Dr. E. Mantho

Address: Highway Engineering Laboratory (for the ISRBT2016 Seminar) School of Civil Engineering Aristotle University of Thessaloniki, 541 24, Thessaloniki, Greece

Phone: +30 2310 994385 and +30 2310 995804

E-mail: [isrbt@civil.auth.gr](mailto:isrbt@civil.auth.gr)

Website: <http://isrbt2016.civil.auth.gr/>

FOR FURTHER DETAILS, PLEASE REFER TO THE WEBSITE OF THE SPECIFIC CONFERENCE

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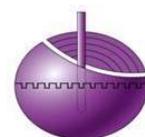
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