SIMSG ISSMGE

ISSMGE Bulletin

Volume 13, Issue 2
April 2019

International Society for Soil Mechanics and Geotechnical Engineering
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Research highlights

Geomechanics group, University of Southampton, U. K.

Southampton's Geomechanics Group resides within the Department of Civil, Maritime and Environmental Engineering, School of Engineering, in the Faculty of Engineering and Physical Sciences of the University of Southampton. It has 7 members of academic staff, and around 20 doctoral and post-doctoral researchers. Staff expertise and areas of active research can be classed under four broad categories: a) Transportation Geotechnics, b) Offshore Geotechnics, c) Environmental Geotechnics and d) Fundamental Geomechanics. The Group draws research funding from a broad range of sources, including UK's Research Councils, the European Union and Industry, the close ties with which also facilitate the uptake of the Group's research by practicing engineers. The Group is a member of the "ALERT Geomaterials" European network.

William Powrie, Professor of Geotechnical Engineering. William's main technical areas of expertise are in geotechnical aspects of transport infrastructure, and sustainable waste and resource management.

His work on geotechnical aspects of transport infrastructure encompasses groundwater control, in-ground construction to reduce environmental impacts in urban and other sensitive areas, understanding and mitigating vegetation and climate change effects, and fundamental soil behaviour. Major projects include the A55 Conwy Crossing and HS2. He is co-author of Construction Industry Research and Information (CIRIA) reports C750 *Groundwater control: design and practice* (2016) and C760 *Guidance on embedded retaining wall design* (2017). William's work in waste and resource management focuses on landfill engineering and aftercare. He is co-author of the Institute of Wastes Management report on *The role and operation of the flushing bioreactor*. He worked on the design and engineering risk assessment of the low level radioactive waste repositories at Drigg, and was an expert witness in connection with the Cranbourne Landfill (Victoria,

Research highlights

Geomechanics group, University of Southampton, U. K. (Con't)

Australia). He chaired the Technologies Advisory Committee for Defra's £30M programme of research and demonstrator projects for new technologies for the treatment of biodegradable waste. He is author of the textbook *Soil mechanics – concepts and applications* (Taylor & Francis 1997, 2004 and 2014), and has been Geotechnical Consultant to water management specialists WJ Group since 1987.

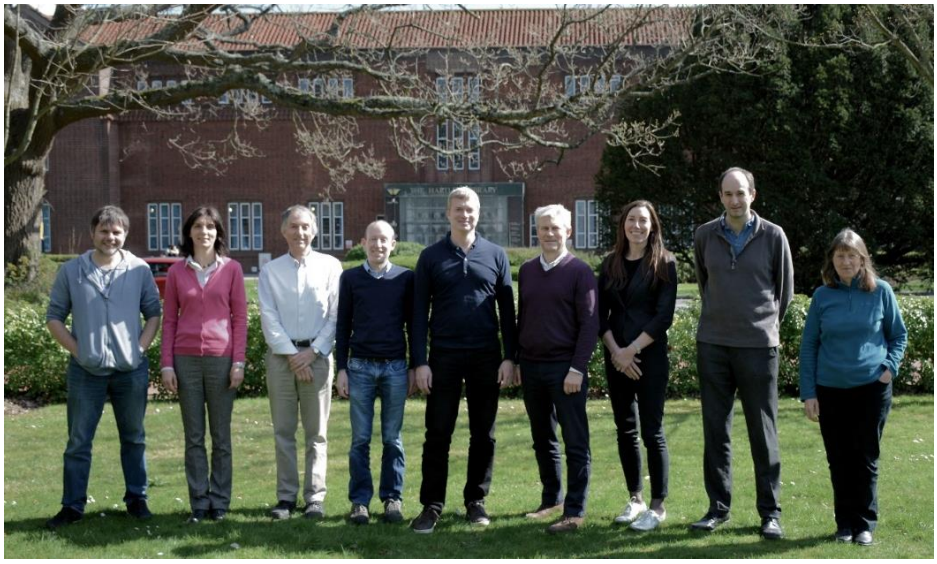


Figure 1. Some members of Southampton's Geomechanics Group (left to right): G. Watson, M. Pinho Lopes, W. Powrie, J. Smethurst, D. White, D. Richards, S. Gourvenec, L. Le Pen and A. Stringfellow.

David Richards, Professor of Ground Engineering and **Head of the School of Engineering.** David's technical interests include the geotechnical aspects of ageing infrastructure, large-scale field monitoring, the engineering behaviour and characterisation of landfill wastes, and the mechanical characterization of chalk using CT imaging and cyclic simple shear tests. He has undertaken extensive studies into the rate loading effects of electricity transmission tower (shallow) footing systems involving both scaled physical modelling techniques in a geotechnical centrifuge and through field monitoring. He is PI for the £26M BEIS/EPSRC funded UKCRIC National Infrastructure Laboratory on the Boldrewood Campus and UKCRIC Coordination Node (CN) Director of Strategy – the CN is working to deliver a networked suite of national research test facilities. David was awarded a Gledden Senior Visiting Fellowship by the University of Western Australia, Centre for Offshore Foundation Systems in 2001. He is a co-recipient of the IMechE Thomas Hawksley Gold Medal and the John F Alcock Memorial Prize, 2007, an ICE Telford Premium, 2009 and the ICE Curtin Medal, 2016.

Susan Gourvenec is **Professor of Offshore Geotechnical Engineering and Deputy Director of the Southampton Marine & Maritime Institute.** Susan's geotechnical expertise covers developing technologies and methodologies to characterise the engineering properties of the seabed and advance geotechnical design of infrastructure that is founded on or in the seabed. Susan's research is based on a blended approach of theoretical, numerical and physical modelling, laboratory and field testing. Susan works in a transdisciplinary context to address challenges including decommissioning offshore infrastructure and vessel loss due to liquefaction of granular cargoes. Susan teaches undergraduate and postgraduate students in civil and maritime engineering, delivers short courses for industry, is co-author of the book *Offshore Geotechnical Engineering*, has chaired and co-edited the proceedings of the *International Symposia of Frontiers in Offshore Geotechnics* s and writes for mainstream audiences in *The Conversation*. Susan works collaboratively with industry partners through research projects and through her role as a consultant to industry. Susan is a Fellow of the Institution of Engineers Australia, a Fellow of the Institution of Civil Engineers and Convenor of the International Standardisation Organisation (ISO) Work Group developing offshore geotechnical design industry standards.

Research highlights

Geomechanics group, University of Southampton, U. K. (Con't)

David White, Professor of Infrastructure Geotechnics, is a geotechnical engineer with research experience related to a range of infrastructure, from offshore energy facilities to onshore civil engineering projects. His contributions include (i) popularisation of image-based deformation measurements in geotechnical modelling, via the geoPIV-RIG (www.geopiv-rg.com) software now used by dozens of universities worldwide; (ii) the establishment of new design methods for pipeline/cable-seabed interaction now found in global standards; and (iii) the development of novel in situ testing tools – including the toroid, ring and hemiball penetrometers - to characterise the very shallow seafloor (www.rigssjip.com). Dave is a Co-Director of the UK's Offshore Renewable Energy Supergen Hub. He has published 350 papers, winning 10 paper prizes, and his research projects have attracted 10 awards. He is a Fellow of the Royal Academy of Engineering, the Institution of Civil Engineers and the Australian Academy of Engineering and Technology.

Joel Smethurst, Associate Professor in Geotechnical Engineering. Joel's main technical interest is in geotechnical transport infrastructure, including the long-term performance, deterioration/aging, and failure of geotechnical structures, and their upgrade and repair. This includes: (i) the effects of vegetation and climate on the performance of earthworks (cuttings and embankments), including the mechanical stabilisation of soil by plants roots; (ii) the stabilisation of both infrastructure slopes and large landslides using discretely spaced piles; (iii) the use of terrestrial laser scanning, and development of novel slope instrumentation approaches; (iv) coastal recession processes; and (v) the design of retaining walls and ground-contacting basement slabs in clay. Much of the research is based on field measurement of the performance of real structures, often over long periods of time, with one instrumented slope site having been monitored continuously for 15 years. In many cases, field data have been used to calibrate numerical models which are used to further investigate behaviour and/or performance. Joel is one of the Scientific Editors of Quarterly Journal of Engineering Geology and Hydrogeology, and is also the current chair of the Institution of Civil Engineers South Geotechnical Group.

Antonis Zervos, Associate Professor in Geomechanics. Antonis's technical area of expertise is the constitutive and numerical modelling of geomaterials. He is an experienced numerical modeller with significant expertise in programming and using finite element and finite difference codes, as well as using boundary element and distinct element software. He has an active interest in the mechanics of railway ballast and ballasted track, the mechanics of catastrophic landslides, the mechanics of oceanic sediments bearing gas-hydrates and in modelling the effects of material microstructure. Before joining Southampton, first as a research assistant for Schlumberger Cambridge Research and then as a freelance consultant, he carried out research and consultancy on petroleum geomechanics. He is a member of the Executive Board of UK's Association for Computational Mechanics and the Board of Directors of the ALERT/Geomaterials European network. He was co-recipient of the Institution of Civil Engineers' 2017 Baker Medal and the British Geotechnical Association's 2017 Medal.

Margarida Fernandes de Pinho Lopes, Lecturer in Geomechanics. Margarida's main technical areas of expertise are in the application of geosynthetics to civil engineering, particularly for soil reinforcement. Her work includes assessment of the mechanical response of geosynthetics, their interfaces with soils, and durability, particularly installation damage and creep. Current research interests include development of constitutive models for geosynthetics to represent their thermo-visco-elastic-plastic and direction-dependent behavior and allow for the influence of durability; micro-reinforcement of railway ballast; and definition of design parameters for reinforcements. Margarida is a member of the Editorial Panel for Proceedings of ICE Geotechnical Engineering and for International Journal of Geosynthetics and Ground Engineering and of the EPSRC Peer Review College. She is a member of various technical committees on geosynthetics for ISO, CEN, BSI and IPQ, International Geosynthetics Society, IGS, and ISSMGE (TC218 Reinforced Fill Structures, TC306 Geo-Engineering Education); she is a member of the IGS UK committee. Margarida's research interests include less traditional topics, such as geotechnical engineering education.

Research highlights

Geomechanics group, University of Southampton, U. K. (Con't)

Richard Beaven, Principal Research Fellow. Richard is a hydrogeologist by training and specializes in landfill related research, having started his early career working for a large UK based Waste Management Company. His main technical expertise is in landfill hydrogeology and landfill processes. He designed the internationally unique Pitsea waste compression cell which facilitated some of the first research that coupled the geotechnical and hydrogeological properties of landfilled wastes. The main focus of Richard's research is developing more sustainable landfill design and addressing the problem of the long-term (centuries) burden of landfill aftercare caused by current landfill design and operation. More recently he is researching controls over the contaminant transport of pollutants in landfills that will have an impact on landfill aftercare and remediation strategies. He runs the UK's landfill aftercare forum LANDSS and is an Associate Editor of Elsevier's journal Waste Management.

John Harkness, Senior Research fellow. John's research interests lie in the understanding and optimization of granular material behaviour, often explored via discrete element modelling with reference to experimental data. He has developed a potential particle code for the modelling of non-spherical particles, used in the modelling of dry-stone walls, locked sands and railway ballast. Recently his research has focused on the measurement and modelling of damage at particle contacts, the effects of particle shape and improving railway track performance.

Louis Le Pen, Senior Research Fellow. Louis specialises in laboratory testing and field research into the performance of railway track systems. Over the past 15 years he has worked on research projects funded mainly by the UK's EPSRC, Network Rail and the European Union. He has authored over 40 publications and his work has been recognised most notably by an honourable mention for the Quigley award (Canadian Geotechnical Journal) and the BGA medal (Geotechnique). He is also co-editor of the Cross-Industry Track Stiffness Working Group's "A Guide to Track Stiffness".

Anne Stringfellow, Senior Research Fellow. Anne's research interests range from contaminant transport in landfills, and solute/waste and solute/barrier interactions (sorption and biodegradation), to waste management systems and technologies. She is currently researching macroscopic flow and transport in the unsaturated zone of waste repositories. Recent work includes an assessment of coastal landfills impacts on shoreline management in the UK. Anne's other research interests contribute to improved management of sensitive water courses in the UK through identification of the sources of organic matter in river sediments.

Nick Woodman, Senior Research Fellow. Nick's research focuses on modelling of coupled physical processes in highly heterogeneous soils and groundwater. Recent projects include researching large-scale deep hydrothermal circulation in the Southern Alps of New Zealand, analysis of thermal pile heat exchange systems, predicting soil water hydrology under future climate and interpretation of field and laboratory-scale tracer tests through contaminated waste. He is interested in poro-mechanics, developing models for surface displacements and groundwater pressures in the Bangladesh Aquifer System and for examining the hydro-mechanical influences effect of plant roots on slope failure.

Taufan Abadi, Research Fellow. Taufan specialises in large-scale laboratory testing of railway track components, mainly ballast and sleepers, to investigate their contribution into the performance of railway track systems. He has been carrying out research in this field for more than 9 years, with funding mostly from EPSRC, through the *TRACK21* and *TRACK to the FUTURE* Programme Grants.

Research highlights

Geomechanics group, University of Southampton, U. K. (Con't)

Anthony Blake, Research Fellow. Anthony's main research interests are geotechnical field testing, instrumentation and monitoring. During his PhD, he carried out centrifuge and large-scale field testing to assess the geotechnical performance of a novel deep water anchoring for the oil and gas industry, subsequently licensed to industry. He previously worked for Bombora Wave Power on the installation, instrumentation and monitoring of a prototype 'mWave' wave energy converter. Active projects include: (ii) Screw piles foundations for offshore wind; (ii) Railway overhead line electrification mast foundations; and (iii) Assessment, costing and enhancement of long - life, long-linear assets (Achilles). He received the 2017 ASTM C. A. Hogentogler Award for a paper of outstanding merit on soils for engineering purposes.

Edgar Ferro, Research Fellow. Edgar's research has focused mainly on the mechanical behaviour of railway ballast and its interaction with plain line sleepers and switch-and-crossing long bearers. He has planned and carried out over 30 full-size laboratory tests in the Southampton Railway Testing Facility as part of EPSRC grants, European Union funded projects and collaborations with industry partners, such as Network Rail. Edgar has also been involved in track monitoring and he is currently working on modelling the long-term response of ballast to cyclic loading.

David Milne, Research Fellow. David's research interests relate to the field monitoring of the performance of railway track. His focus is on the use of novel and lower cost sensors for monitoring of low frequency track vibration. Recent work has involved lineside deployments over extended periods of time and over longer lengths of track to detect changes in and understand the variability of track performance. He has worked closely with Network Rail High Speed on the High Speed One railway line, to develop continuous lineside monitoring techniques and the automated processing methods necessary to analyse large volumes of data to inform, improve and evaluate maintenance in critical zones on that railway.

Madhusudhan B.N Murthy, Research Fellow. Madhu's expertise is in experimental geomechanics, with a focus on building a fundamental understanding of geomaterial behavior and applying it to research themes such as micromechanics of railway ballast, mechanics of landslides, mechanics of gas hydrate bearing sediments, ground improvement and soil dynamics. He is currently involved in: 1) The development of sustainable ways to reuse and recycle railway ballast by investigating the role of particle shape, surface characteristics and contact mechanics, 2) The characterisation of submarine slope instabilities using 4D X-ray CT, 3) The mechanics of chalk, and 4) The dynamic characterisation of soft soils for railway infrastructure. He has co-authored over 17 research papers. Before moving to Southampton he obtained his PhD from the Indian Institute of Science and was post-doctoral researcher at the University of Hong Kong.

Tristan Rees White, Research Fellow. Tristan is principally an experimentalist, specializing in designing, implementing and monitoring experiments in the laboratory and at various scales in the field. The focus of his research has been on the effectiveness of contaminant removal from landfills through flushing, by carrying out full-scale tracer test experiments at a number of field sites across the UK and in Europe. Other research areas have included the development in the UK of the tracer gas dispersion method for whole-site monitoring of methane emissions from landfill and other point sources of methane generation, and research into the aerobic treatment of wastes.

Geoff Watson, Research Fellow. Geoff specialises in laboratory testing of soils and landfill wastes and field research into the performance of railway track systems and landfill engineering. He has also contributed to the work on the UK's infrastructure, as an author on the UK's second Climate Change Risk Assessment and as a reviewer on the first National Infrastructure Assessment completed by the UK's National Infrastructure Commission. Over the past 17 years he has worked on research projects funded by the UK's EPSRC, Network Rail, the European Union, Defra and industry in the UK and overseas. He has authored over 20 publications.

Research highlights

Geomechanics group, University of Southampton, U. K. (Con't)

Research facilities

Currently based at the University's Highfield Campus, the Geomechanics Group's labs accommodate, in addition to standard equipment for soil testing, a wide range of advanced soil element testing apparatus: stress path triaxial, dynamic triaxial, dynamic simple shear, a hollow cylinder, a number of resonant columns, and Southampton's bespoke Gas Hydrate Resonant Column (the first one of its kind) and Gas Hydrate Triaxial apparatus, both developed and built in-house for testing hydrate bearing soils.

In May 2019, the Group will move to *The National Infrastructure Laboratory (NIL)* at the University's Boldrewood Innovation Campus, which is a joint national and University investment in teaching and research laboratories. The NIL will accommodate the general facilities needed to extend current world-leading research in geomechanics and linear infrastructure, experimental structural mechanics and complex/composite materials characterization. Due for completion/hand over in May 2019, the NIL will accommodate the academic, research and support staff associated with the civil engineering taught programmes. As part of the move the Geomechanics Group will commission a new 3m radius C67-4 Actidyn geotechnical centrifuge, acquire access to a 14.2m x 28.5m strong floor hall for railway track testing, and double its general lab space area, creating a host of new opportunities for expanding its research activity.

Figure 2. The National Infrastructure Laboratory at the University of Southampton. Inset: Delivery of the Actidyn C67-4 geotechnical centrifuge

Research highlights

Geomechanics group, University of Southampton, U. K. (Con't)

Research

Transportation Geotechnics

1. Track to the FUTURE (T2F)

TRACK to the FUTURE (*T2F*) is a £8M, five year Programme Grant funded by EPSRC, the rail industry and the participating universities to develop railway track systems that are ***efficient in terms of embodied carbon, materials use and cost; robust in requiring little maintenance; and unintrusive in producing little noise***. This is important in the light of increasing societal expectations of railway systems in terms of capacity and speed (e.g. a proposed loading of 60 equivalent million gross tonnes per annum and a maximum speed of 350 km/h on HS2); service availability (e.g. LUL's Night Tube); affordability; and increasing intolerance of noise and vibration.

With partner universities Birmingham, Huddersfield and Nottingham, we are developing new track forms that prolong material and system life, require less maintenance, reduce noise and address the intricate dynamic vehicle / track / substructure interactions especially at transitions and crossings. Our investigations use state-of-the-art experimental, analytical and field monitoring techniques to take account of the millions of cycles of complex loads to which track systems are subjected in a modern railway environment; non-uniformities of load; and non-linearities of response.

TRACK to the FUTURE addresses three interlinked Research Challenges (RCs):

- *TRACK4LIFE* (RC1): low-maintenance, long-life track systems with optimised material use
- *DESIGNER CROSSINGS AND TRANSITIONS* (RC2): crossings and transitions that optimise vehicle behavior through them, hence maximising resistance to damage
- *NOISE-LESS TRACK* (RC3): an integrated approach to designing a low-noise, low-vibration track consistent with reduced whole-life costs and maintenance needs.

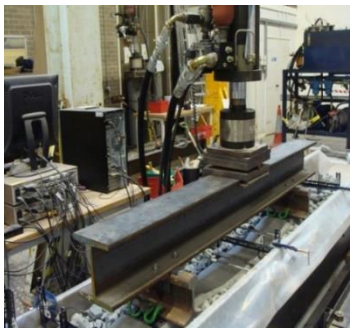
Our investigations use laboratory testing facilities both for small elements of soil and larger scale elements of track; computer modelling of the interaction between superstructure and substructure focused on the transfer of load at the grain scale (discrete element modelling, DEM), and field measurements of track movements using geophones, accelerometers, high speed filming and field measurements of soil/structure interaction pressures. Some examples are given below:

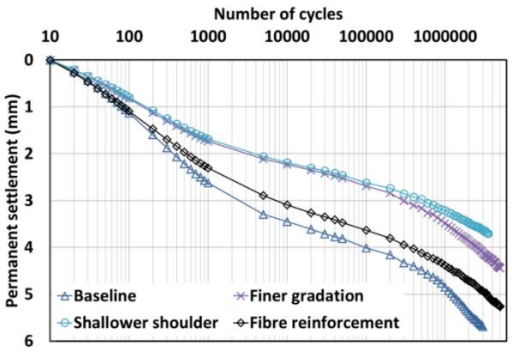
Field performance monitoring. We have developed three complementary systems to measure track performance, based on seismic sensors (geophones), accelerometers and high speed filming, the latter using a target attached to a sleeper end or rail to provide scaling and texture. All three systems measure the dynamic performance of track along discrete lengths, typically over 20 to 40 bearers. Measurements over repeat visits allow assessment of ongoing changes in track performance. The data is processed to provide bearer acceleration, velocity and displacement, and infer track support stiffness.

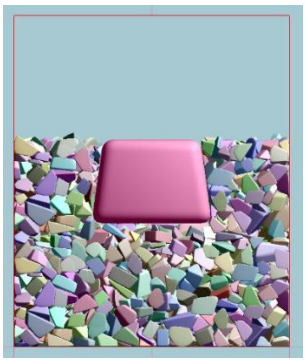
The Southampton Railway Testing Facility (SRTF). This is a purpose-built apparatus for full scale tests of sleeper behaviour, in which 3 million loading cycles of a 20 tonne equivalent axle load may be applied on a single sleeper bay (Fig. 3a). This is equivalent to 2 years traffic on a busy line and 5 years on a moderately busy one. Measurements include permanent (Fig. 1b) and resilient settlements, ballast shoulder movements, grain breakage, longitudinal stress within the ballast bed and, using pressure-sensitive paper, the number of ballast-sleeper contacts and the overall contact area. The SRTF can also carry out lateral pull-out tests.

Research highlights

Geomechanics group, University of Southampton, U. K. (Con't)







(a) (b) (c)

Figure 3. a) photograph of the SRTF laboratory tests, b) Settlement data from typical tests in the SRTF – comparison of different ballast arrangements, and c) Typical 3D DEM model showing sleeper and ballast.

Discrete element modelling. We have developed a 3D discrete element (DEM) code for modelling non-spherical particles, such as ballast, based on the method of "potential particles". One application is the investigation of the vertical settlement of a ballasted sleeper subjected to cyclic vertical loading. Ballast particles are modelled as irregular forms with slightly rounded corners, edges and faces, interacting using Hertzian contact. A library of 13 different shapes were created in a range of sizes to match quantitatively the shape parameters and grain size distributions of real ballast. Fig. 1c shows a typical model.

2. Railway overhead line electrification mast foundations

Recent railway overhead line electrification (OLE) schemes in the UK have been excessively costly, resulting in their curtailment or cancellation. One of the reasons was a substantial increase in mast foundation pile lengths compared with historic practice. Research at Southampton has explored the reasons for this, through comparative analyses and field tests of trial foundations. The results demonstrated the robustness of the traditional empirical approach based on a series of field tests carried out under the auspices of the UIC in the 1950s, and its suitability for the higher loads associated with modern OLE masts and equipment. Results have been incorporated into Network Rail's updated design guidance, first use of which is demonstrating a marked improvement in productivity, helping the UK's electrification program get back on track.

3. Geotechnical engineering for high speed railways

The operation of railways for train speeds in excess of about 200 km/hour brings its own challenges in terms of train / track / ground interactions. Relevant projects at Southampton include (i) geotechnical and aerodynamic assessment of the factors influencing the potential for ballast flight during high speed train passage (field monitoring and CFD train / air / track / ballast interaction analysis); (ii) selection of parameters and methods of analysis for the assessment of possible critical velocity sites and effects; and (iii) development and demonstration of targeted defect repair methods on high speed railway lines.

4. Mechanical plant root stabilisation of soils

Rooting for Sustainable Performance is a 4 year EPSRC project with partner institutions of the Universities of Dundee and Aberdeen, and the John Hutton Institute. It is developing new models for plant root reinforcement of slopes, to reliably account for root stabilisation effects in existing slopes and the design of new earthworks. At Southampton we X-Ray CT scan soil samples containing plant roots under shear to investigate the mechanisms of root reinforcement, and create whole slope numerical models to help to understand how root reinforcement can enhance the performance of existing slopes and may be accounted for in design. The shear box tests developed at Southampton have involved the design of a new shear rig that can go in the University's large X-ray CT scanner (Fig. 4a&b). The scanned images of sheared plant and soil are analysed through use of digital volume correlation (DVC) which calculates strains and displacements in three-dimensions (Fig. 4c).

Research highlights

Geomechanics group, University of Southampton, U. K. (Con't)

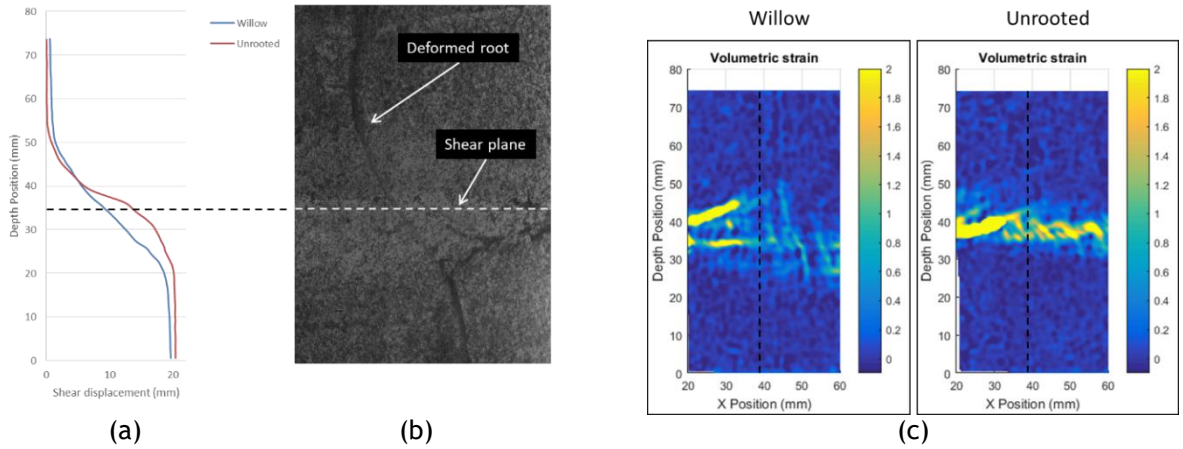


Figure 4. (a) local shear displacement vs. depth above and below the shear plane for 20 mm shear displacement, (b) a deformed vertical root following the shape of the shear band, and (c) full-field volumetric strains on a profile through the middle of the sample, following the direction of shear.

5. Impact of climate and vegetation on earthworks

ACHILLES is a major programme grant, funded by EPSRC, and of which Southampton is one of seven partner institutions (led by Newcastle, and with the Universities of Loughborough, Leeds, Bath, Durham and the British Geological Survey). ACHILLES is building on the work carried out in a project called iSMART, to improve models of deterioration and failure and the impact of climate change on geotechnical assets. As well as infrastructure earthworks, the project is considering other long, linear geotechnical infrastructure such as flood embankments and pipeline bedding. Failures in engineered earthworks during wet winters cause considerable disruption, and pose a safety risk to transport operations in the UK.

The major Southampton role in both research projects has been in site instrumentation and monitoring to measure seasonal changes in pore water pressures and displacement within engineered embankments and cuttings, and develop conceptual models of physical processes to help to understand how the slopes deteriorate with time. This has included associated measurements of in-situ changes in soil structure via clay cracking, and how that changes near-surface permeability and soil water retention behaviour. Both projects have supported the continued monitoring of a cut highways slope in London Clay at Newbury, to the north of Southampton, that has been monitored for 15 years, and has become a well cited dataset.

6. Slope stabilisation techniques

The major work on slope stabilisation techniques has been around the use of discretely spaced piles to pin through unstable or a potentially unstable soil mass into more stable underlying ground. Their use in UK infrastructure slopes usually involves a single row of bored concrete piles, placed about one-third of the way up the slope, and at centre-to-centre spacings of about 3 to 4 pile diameters. Research work at Southampton has involved instrumentation and monitoring of the slopes and piles to understand relative pile and soil movements and the structural loads being applied to the piles, in order to inform and improve the pile design approach. Numerical modelling has also been used to understand fundamental modes of pile-soil interaction, as well as limiting effective earth pressures that may act on the pile wall.

Research highlights

Geomechanics group, University of Southampton, U. K. (Con't)

Offshore Geotechnics

Southampton has a long track record of research and teaching related to offshore engineering and the oceans, led through the Southampton Marine & Maritime Institute (SMMI), which has been based since 2014 at the Boldrewood Innovation Campus, next to the Lloyds Register Global Technology Centre. In 2017, Susan Gourvenec and David White joined the Geomechanics Group from the University of Western Australia, bringing new geotechnical and interdisciplinary expertise related to ocean engineering. The Geomechanics Group is currently involved in projects linked to renewable energy facilities (for wind, wave and tidal energy), oil and gas developments, subsea cable networks, seafloor characterisation and the study of geohazards such as submarine mass movements. Recently-initiated inter-disciplinary projects with involvement across SMMI include studies into the decommissioning of offshore structures and the mitigation of solid bulk cargo liquefaction.

Southampton is a partner in the ARC **Research Hub for Offshore Floating Facilities** (the OFFshore Hub), which is a £6M initiative led by the University of Western Australia and supported by Shell, Woodside, LR and BV. Southampton is involved in OFFshore Hub projects on riser and mooring design, novel anchors and subsea foundations. The research program involves a blend of physical and numerical modelling supported by fieldwork and analysis of observations from existing facilities. Southampton is also part of the UK's **Offshore Renewable Energy (ORE) Supergen Hub**, which is a UK-wide academic network focussed on innovation to support the ORE sector. Southampton is contributing to the characterisation of future ORE sites and the improvement of mooring systems and cable networks.

1. Foundations and pipelines: whole-life design

An emerging trend in the design of subsea infrastructure is the consideration of 'whole life' effects – namely the changes in soil properties and geotechnical capacity over the operating life, which lead to greater resilience. David White and Susan Gourvenec have led research into whole life effects in relation to pipelines, foundations and anchoring systems, particularly in soft clay where the effects are most significant. Seabed pipelines that undergo repeated thermal expansion and contraction cause shearing and consolidation in the underlying soil, which can cause a doubling or tripling of the available seabed friction. Also, foundations are generally subjected to intermittent loads interspersed with periods of consolidation, in advance of any extreme design load. Foundations can even be designed to deliberately 'fail' by sliding across the seabed, relieving applied loads. These also cause a change in seabed strength and geotechnical capacity. Centrifuge modelling and numerical simulations have been used to observe and quantify these effects, and simple design tools have been developed to allow incorporation of these methods in everyday design practice. This work has been supported by a variety of offshore energy operators and contractors, is being used on projects, and elements of it have been adopted in design guidelines and international standards.

2. Cable-seabed interaction

This is an important consideration in the design of renewable energy facilities and for interconnectors. Calculation methods have been developed for assessing the burial and stability of cables. A recent focus has been rocky seabeds, where cables rest on a rugged seafloor that is stripped of sediment, particularly in high energy environments such as tidal stream energy sites. Collaboration with the University of Western Australia and a range of operators and cable manufactures has led to new methods for calculating the loading and support of these cables, leading to a new and less onerous approach for stability design.

3. Characterisation of the shallow seafloor

Characterisation of the shallow seafloor – meaning the upper metre or so – is important for foundation, pipeline and cable design, but is commonly overlooked in existing site investigation practice. This limitation has been addressed in the past few years by the development of new types of shallow penetrometer - the hemiball, toroid and ring devices. These devices are pushed to a shallow depth then rotated under different forms of speed and load control, allowing a range of soil properties to be derived including both drained and undrained strengths. This technology was advanced through the RIGSS JIP, led by David White and Sam

Research highlights

Geomechanics group, University of Southampton, U. K. (Con't)

Stanier while at UWA. The devices are now accepted by offshore operators and have been used to test large undisturbed samples taken from the seafloor on six projects from three continents. Working with Southampton's maritime robotics laboratory, a next step is to take these devices to the seafloor.

4. Screw piles for wind energy foundation systems

This is a collaborative Supergen Wind project funded through a £1m EPSRC research grant with participation from University of Southampton, University of Dundee, Durham University, University of Western Australia, Cathie Associates, Soil Machine Dynamics and Roger Bullivant and In Situ Site Investigation. David Richards, Anthony Blake and David White lead the Southampton effort (www.screwpilesforoffshorewind.co.uk).
The majority of offshore wind turbines in Europe are supported by large diameter, driven monopiles. Concerns about the effects of pile driving noise on marine life hamper the use of this technology, particularly as hammers get larger to suit bigger piles. Screw piles offer a potential solution with relatively low installation noise. They are widely adopted onshore but will require significant geometric enhancement to meet the demands of the offshore environment, as well as calibration of new design methods. The project has been undertaken to demonstrate the suitability of screw piles as a foundation solution for offshore wind turbines. The project is evolving current onshore screw pile designs to a geometry that is more suited to offshore applications. University of Southampton are responsible for field testing of screw pile geometries optimised for offshore wind turbines, the results of which will serve to validate advanced analytical and numerical techniques. The field testing program was conducted in collaboration with Professor Barry Lehane of UWA, using a sand test site in Perth.

5. Large-scale submarine landslides

Large scale submarine landslides pose a serious threat to human life and infrastructure as they can mobilise a substantial volume of material and affect extensive areas, or even trigger catastrophic tsunamis. With funding from NERC (project "Will climate change in the Arctic increase the landslide-tsunami risk to the UK"), and in collaboration with the National Oceanography Centre Southampton, we investigated mechanisms that may precondition a slope for failure and make the initiation of a landslide possible:

- **Rapid sediment deposition.** Fine-grained sediments accumulating quickly (in geological terms) on the continental shelf may be more prone to instability due to the generated excess pore pressure.
- **Destructuring of marine sediments.** If the underlying sediment was deposited under conditions that promoted an "open" structuring of its particles, continuing deposition at a higher rate could cause these structures to suddenly collapse, thus destabilising the slope.
- **Weak layers.** If thin layers of lower-strength material exist in the sediment, under the right conditions they may act as glide planes and promote failure of the slope.
- **Seismic activity.** Even if they do not cause failure outright, cyclic loads due to earthquakes can disturb sediment structure, increase pore water pressure and bring the sediment closer to failure.
- **Dissociation of gas hydrates.** Gas hydrates are solid compounds of natural gas and water that are found in some oceanic sediments and are only stable under particular high-pressure, low-temperature conditions. Increasing temperature or decreasing pressure, e.g. due to climate change, may dissociate them into gas and water, leaving the host sediment significantly weakened and promoting instability (Fig.5.)

Research highlights

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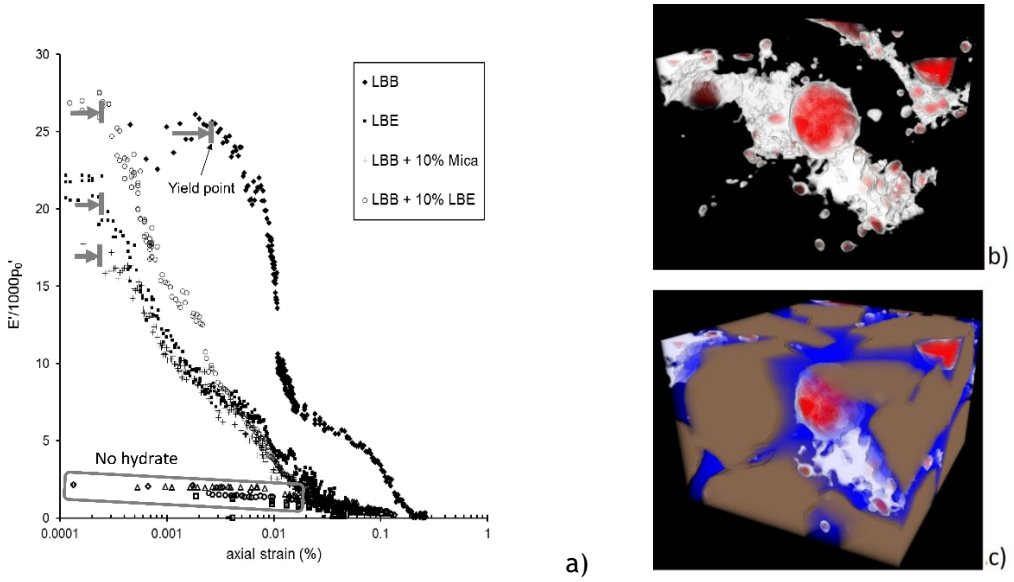


Figure 5. Effect of methane hydrate on mechanics of submarine slope sediments: a) Effect of particle shape and size on the stiffness of cemented hydrate sediments, b) X-Ray CT characterisation of hydrate in pore space (hydrate in white, methane gas in red) and c) Evolution of hydrate within porespace.

Environmental Geotechnics

1. Geotechnical and hydrogeological properties of landfilled waste

Southampton has a long history of investigating the geotechnical and hydrogeological properties of waste benefiting from a large scale, 2m diameter waste compression cell (Fig. 6) capable of replicating landfill depths up to ~60 metres (600 kPa). Southampton have used the testing facility to quantify the compressional behaviour and the resultant changes in porosity and permeability of different types of waste profiled throughout the depth of a landfill site. The compression cell has also been used to undertake tracer tests to determine the contaminant transport properties of compressed waste under highly controlled conditions. These tests have confirmed the dual porosity properties of landfilled waste and the importance of preferential flow paths in landfills.

Figure 6. Southampton's 2m-diameter waste compression cell.

Research highlights

Geomechanics group, University of Southampton, U. K. (Con't)

2. Environmental control systems and emission monitoring of landfills

Engineered infrastructure and environmental control systems in landfills need to maintain an acceptable level of performance into the future to mitigate the long-term nature of the landfill's pollution load. The clogging of leachate collection systems is a cause of elevated leachate levels in some landfills. Research at Southampton on a range of different drainage media, including systems constructed from engineered tyres, has led to recommendations on ways in which drainage systems can be protected from clogging. Research has also involved the use of innovative retro-fitted leachate control systems including the drilling and installation of horizontal leachate and gas control wells. Monitoring of a landfill, should include the monitoring of emissions as an indication of the performance of the infrastructure and control systems. Southampton is applying the tracer release dispersion method to monitor whole-site emissions of methane from landfills. In this technique a controlled release of a tracer gas (acetylene) is made from the surface of the landfill and interpretation of the downwind monitoring of the plumes of methane and acetylene provides the methane emission flux from the site.

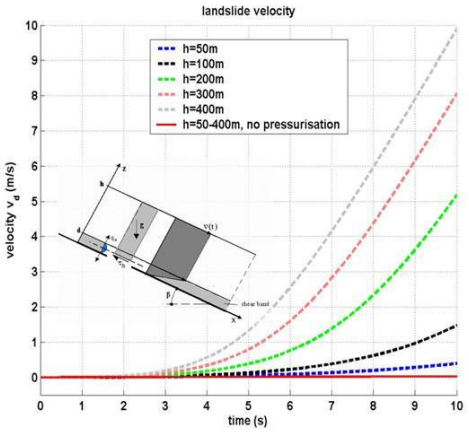
3. Dutch Accelerated Remediation Trial (DART)

Southampton is collaborating in an internationally unique landfill project –the €15M Dutch Accelerated Remediation Trial (DART) in the Netherlands. This project aims to bring three landfills out of 'after-care' within the next decade. Current methods of management following landfill closure result in after-care periods lasting centuries, which is unacceptable from a sustainability perspective. DART aims to reduce the after-care period by improving the quality of leachate by different methods of treatment including aeration and accelerated leachate recirculation and flushing. Solute flushing is a reactive transport problem, coupling geochemical reactions and sorption/desorption with physical flow and diffusion. Previous studies have demonstrated that preferential flow in unsaturated wastes has a significant controlling influence on solute flushing. Southampton is investigating unsaturated zone flow paths in landfilled waste to develop a detailed understanding of how they influence contaminant flushing. Existing numerical models on contaminant flushing will be enhanced to provide confidence that improvements to leachate quality achieved during the accelerated remediation will be maintained into the future.

Fundamental Geotechnics

1. Thermomechanics of lanslides

Large-scale landslides can seriously threaten human life and infrastructure over extensive areas, by rapidly moving substantial volumes of material. One possible explanation for why some landslides develop into catastrophic events is frictional heating, i.e. that friction increases temperature and causes expansion of pore water, collapse of the soil skeleton and pressurisation of the slip plane, greatly diminishing frictional resistance.



We develop models that describe landslide evolution and use them to gain insights on material properties and in situ conditions that may promote catastrophic failure. We account for the dynamics of the moving mass, the thermo-mechanical behaviour of the soil, the production and diffusion of heat, and the resulting increase of pore water pressure and water flow. By further including the rate-dependent behaviour of soil, we can reproduce the possible eventual transition of a creeping slide into a catastrophic event, and investigate the factors determining whether such a transition will take place and when. Results show that lower permeability soils are more prone to thermal pressurisation while, contrary to intuition but in line with geological evidence, thicker and heavier slides are predicted to accelerate faster. Whether a uniform creeping slope reaches a catastrophic phase is governed by the heat and drainage boundary conditions, whereas the timing of the transition depends strongly on the ability of the soil at the slip plane to strain-rate harden.

Research highlights

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2. Engineering in chalk

Chalk underlies vast areas of Northern Europe and the North Sea. It is a weak biogenic rock, largely composed of a coccolith-based low-magnesium calcite matrix, in which foraminifera, authigenic calcite and very limited amounts of clay are found. Engineering activities such as tunneling, earthworks and pile driving mechanically destructure chalk, forming a putty-like mixture of whole and broken coccoliths and the platelets that compose these. This chalk putty, which may form a 'sleeve' or 'annulus' around driven piles in chalk, exhibits low strengths in the short-term but may build-up strength with time. We investigated the penetration of model piles in chalk experimentally, using the μ-VIS X-Ray CT facility at Southampton (Fig.7) to gain insights into the processes of chalk destructuring and putty formation during pile penetration. To quantify shaft friction during and post-installation of piles in chalk, we also developed a critical state framework for the chalk putty. Finally, we used cyclic simple shear tests to gain insights into its performance under loads consistent with those from an offshore wind turbine.

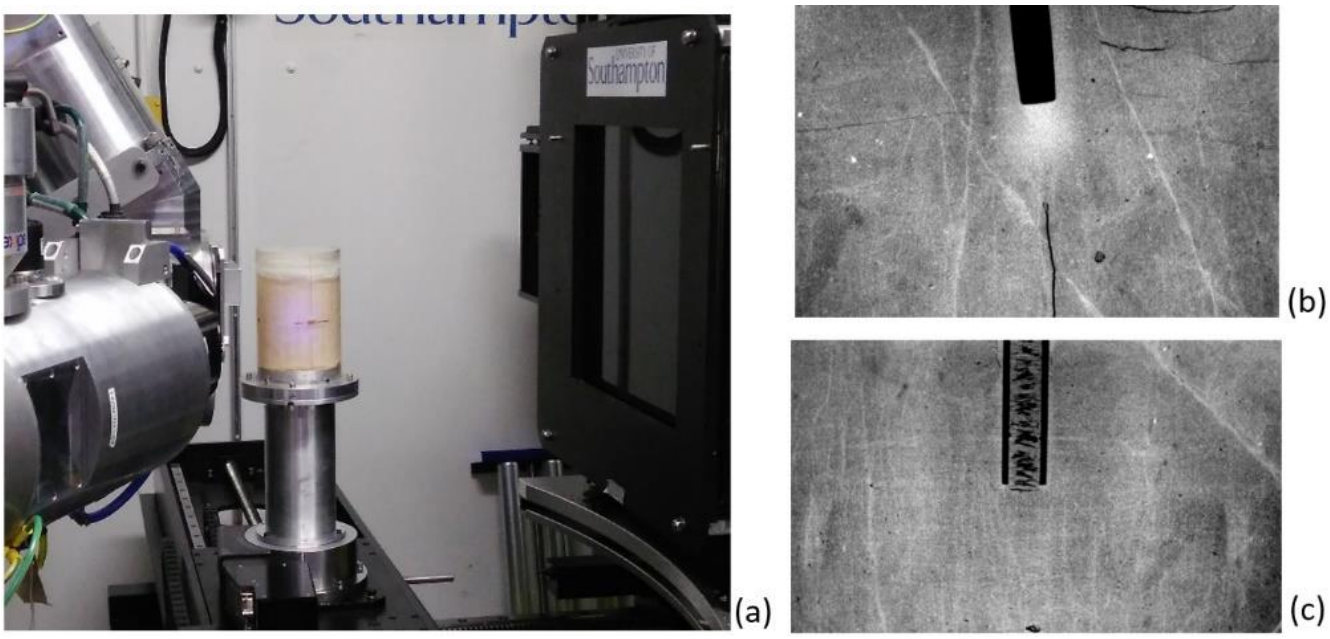

Figure 7. Model pile penetration experiment captured using X-ray micro CT: a) μ-VIS 450 keV CT scanner, b) solid pile penetration in white medium chalk, and c) hollow pile penetration in white medium chalk.

3. Constitutive models for geosynthetics

Often, numerical analyses represent geosynthetics using linear elastic or elastoplastic models. However, the thermo-visco-elastic-plastic and direction-dependent behaviour of geosynthetic reinforcements can have a significant influence on the overall performance of a structure. In addition, mechanisms and agents affecting the durability of geosynthetics can alter significantly their stress-strain response. Current research focuses on developing constitutive models that can reproduce the complex response of geosynthetics and also allow for changes related to durability. Fig. 8 illustrates results for simple models used to represent the short-term tensile response of two geogrids, undamaged and exhumed after field installation damage with two compaction energies.

Research highlights

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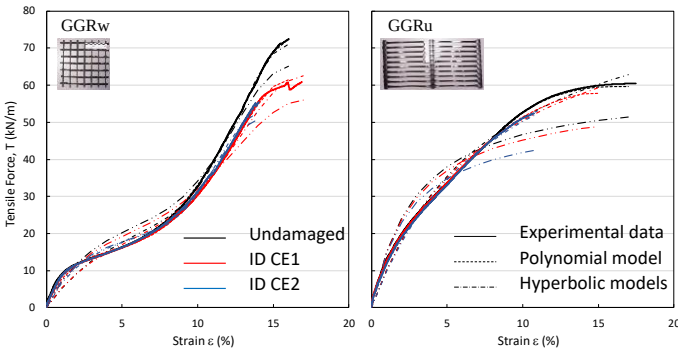


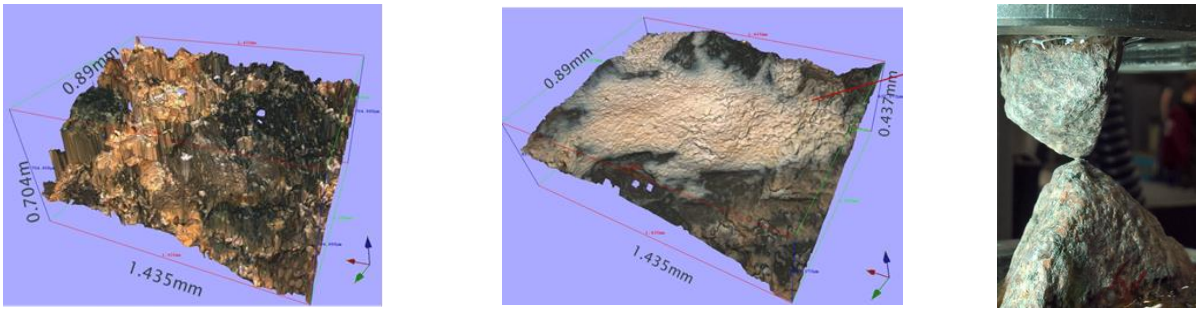
Figure 8. Example of simple constitutive models used to represent the short-term tensile response of two geogrids (GGRw and GGRu), undamaged (UND) and exhumed after field installation damage with two compaction energies (ID CE1 and ID CE2).

4. Design parameters for geosynthetics

The durability of geosynthetics is key to their design and is influenced by installation damage (normally associated with mechanical damage), sustained load (static or dynamic), temperature, weathering and chemical degradation. Particularly for reinforcement applications, current practice requires estimating the long-term allowable strength of the reinforcements available at the end of the design life by determining separate reduction factors representing the strength loss expected due to different unrelated mechanisms. Recent work isolated the long-term response (creep and creep rupture) of undamaged and exhumed geosynthetics to enable direct comparison. The results showed that, contrary to what has been reported in the literature, for some geosynthetics the creep rupture response changes after installation damage. Results from creep tests revealed that there is synergy between installation damage and creep and that, depending on the geosynthetics studied, the traditional approach to design can be unsafe.

5. Micromechanics of granular materials

We investigate the effects of particle shape (form, angularity and roughness) on the mechanical behavior of railway ballast, mainly to better understand the mechanical properties of recycled ballast and its potential for reuse. We quantify particle shape using measures of form and angularity developed at Southampton, based on photographic and laser scanning techniques. We can quantify particle roughness and its evolution ("damage") due to cyclic loading of ballast e.g. in the Southampton Railway Testing Facility; c.f. Fig. 7a and Fig. 7b. The effects of particle shape are investigated using our in-house DEM code, which employs potential particles. This makes necessary the development of realistic interparticle contact laws, to support the numerical modelling. We have already published and use a contact law taking into account stress-dependence and damage at interparticle contacts; we currently characterize the properties of interparticle contacts using a bespoke rig (Fig. 7c), to inform further development of our models.



(a) (b) (c)

Figure 7: (a) Particle roughness before testing in the SRTF, (b) particle roughness after testing in the SRTF, and (c) bespoke apparatus to measure the normal and tangential interparticle contact stiffness.

Case study

An innovative method of assessing the capacity of existing wharf piles, Australia

Introduction

The Mackay Outer Harbour is situated in the Northern Queensland of Australia, and was officially opened on 26 August 1939 (see Figure 1). The deep water port became an important facility for the thriving trade of a growing district. In 1957, the bulk sugar handling terminal was open, servicing the sugar industry that started in the region in 1865.

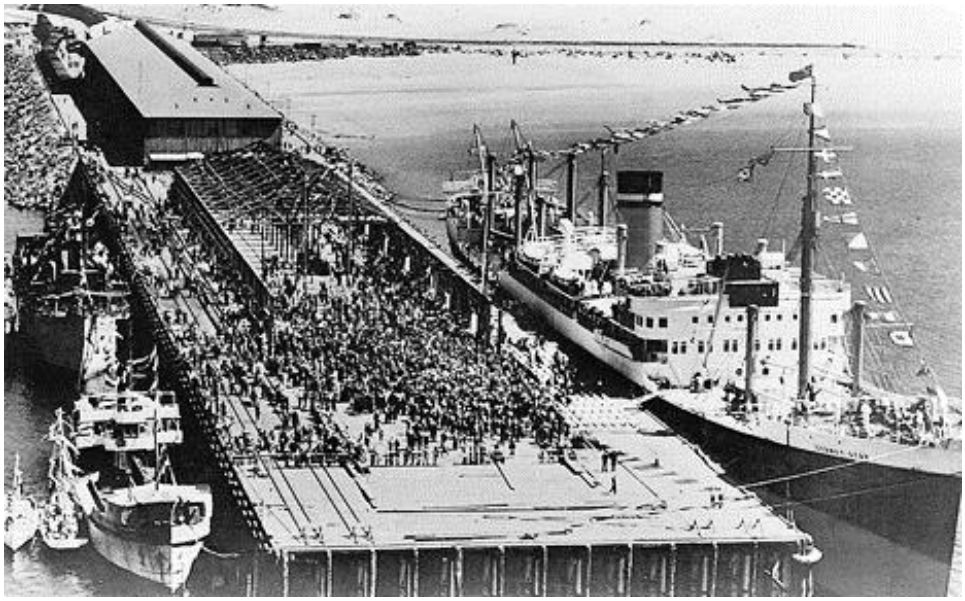


Figure 1. Official opening of Mackay Outer Harbour in 1939 (source: Daily Mercury, https://www.Dailymercury.com.au/news/macky-harbour-70-today/34046/)

Since its opening, various phases of harbor expansion took place under McKay Harbour Board. Wharf no. 4 was constructed circa 1967 and wharf no. 5 followed later under McKay Harbour Ltd which changed to North Queensland Bulk Ports in 2009. The locations of wharves 1, 4 and 5 are shown in Figure 2.

Figure 2. Site plan showing the Wharf and the borehole locations

Case study

An innovative method of assessing the capacity of existing wharf piles, Australia (Con't)

In 2017, NQBP commenced upgrade work on wharves 1, 4 and 5 involves a fender replacement and bollard upgrading programme. As a result of the proposed upgrade, the axial capacity of the fender piles at Wharves 1, 4 and 5 is increased from the original design requirements. The piles supporting the wharves are driven tubular steel piles ranging from 457 mm diameter at Wharves Nos. 1 and 4, to 1000 mm diameter at Wharf No. 5. The required pile capacities are compared to estimated pile capacities made in 2016 by another geotechnical consultant as summarized in Table 1.

Table 1: Pile Loads and Initial Estimate of Capacity

Statistics	Design ultimate (kN)	[1]Available design ultimate capacity (kN)
Compression row C	1135	650
Compression row D	1364	975
Tension	426	225

[1]Estimated by another geotechnical consultant in 2016

Due to the lack of information on as-constructed pile toe levels, final driving energy and sets or pile load testing at the wharves in question, doubts were raised on the ability of the existing piles to carry the revised loads based on the theoretical assessment results shown in Table 1. Contrary to the theoretical assessment, however, a previous dynamic pile load test with CAPWAP assessment on a pile installed at Wharf 3 gave a compression capacity of a 1000mm diameter pile of 1,900 kN in shaft resistance and 5,380 kN end resistance, i.e. 7,280 kN total capacity (or a design ultimate capacity of 798 kN in tension and 5,096 kN using a tension to compression capacity ratio, R_{st} of 0.6 (based on De Nicola and Randolph (1993) and a geotechnical strength reduction factor ϕ_g of 0.7). This is significantly higher than the theoretical estimate made by the other consultant and therefore gave at least some confidence that the existing piles may be able to carry the revised loading associated with the upgrade without remedial works. To confirm this initially assessment, the following programme of investigation was carried out:

- Drilling of 3 boreholes, one at each of Wharf 1, 4 and 5 adjacent to existing piles at the locations shown in Figure 2.
- Conduct downhole magnetic testing in PVC access tubes installed at the completion of the boreholes to assess the toe levels of the adjacent piles.
- Install 457 mm diameter tubular steel test piles to the assessed pile toe levels.
- Conduct dynamic pile load testing and CAPWAP analyses (Rausche et al., 1985) to assess the ultimate pile capacity of the test piles.

The test results and subsequent interpretations are discussed below.

Borehole and downhole magnetic testing

Three boreholes were drilled at the approximate locations shown in Figure 2. It had originally been intended to drill the boreholes within 1 m of the external face of the existing pile for the downhole magnetic testing. Unfortunately, that was not possible due to site access constraints and the boreholes were drilled at distances ranging from 1.3 to 1.6 m. Beyond 1 m distance, the accuracy of the magnetics testing reduces.

Downhole magnetics testing is a passive method based on the measurement of localised perpetrations of the Earth's magnetic field measured in nano-tesla's (nT). These may be caused by geological features and buried ferrous targets (e. g., pipes, cables, drums, iron sheets, steel reinforcement etc).

The magnetics testing was completed in-situ using pre-drilled, PVC cased boreholes. A Bartington 3-component fluxgate magnetometer was used to measure the magnetic field variations at 0.5 m intervals to the maximum depth of the borehole. The magnetic data was acquired with Spectromag-6 software.

Case study

An innovative method of assessing the capacity of existing wharf piles, Australia (Con't)

The borehole magnetometer was lowered from the top of each borehole (from the wharf deck) and repeated magnetic measurements were made at each depth to assist assessment of any external magnetic noise.

The borehole magnetometer measures magnetic field intensity in three dimensions (X, Y and Z) with the vertical (Z) component of the magnetic field typically providing the clearest indication of the base of steel piles and hence the approximate depth of the pile. Furthermore, the vertical first derivative of the vertical component of the magnetic field can also reliably indicate the base of a steel pile. Figure 3 shows a typical magnetic response of a pile as sensed from a proximal borehole adjacent to the pile, including the vertical component and vertical first derivative of the magnetic response. This shows that a magnetic anomaly indicates the approximate base of the pile.

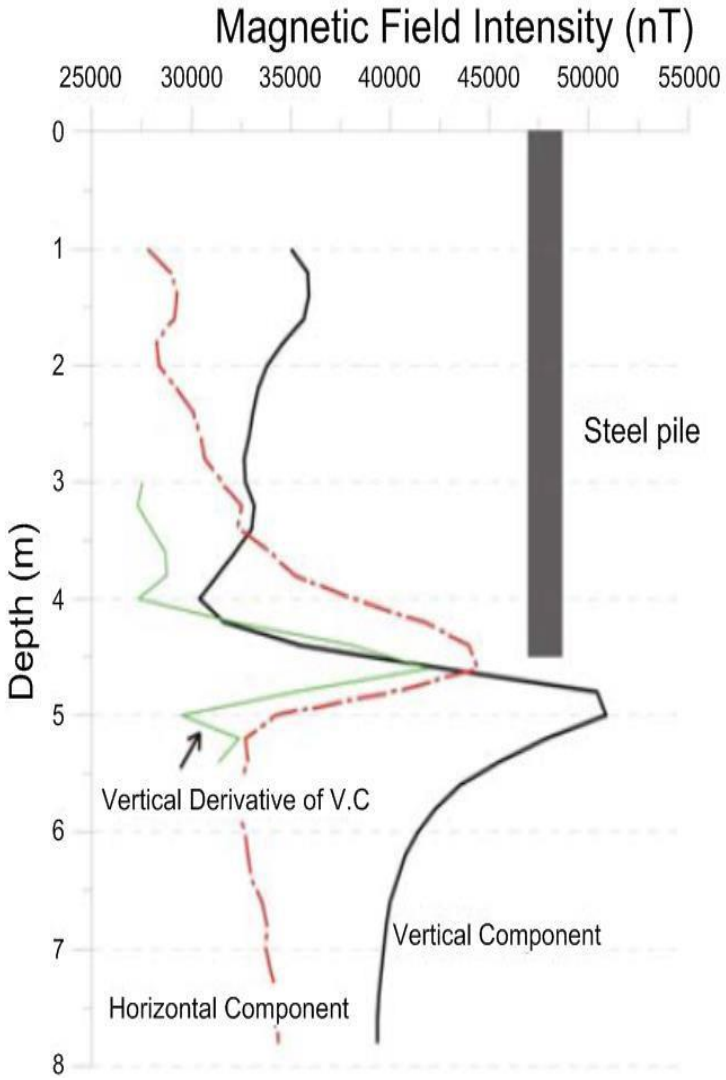


Figure 3. Typical magnetic response of a steel pile (from Jo. et al., 2003)

Case study

An innovative method of assessing the capacity of existing wharf piles, Australia (Con't)

Subsurface profile and inferred pile toe levels

The results and interpretation of the downhole magnetics testing are shown in Figure 4. It can be seen that the clearest magnetic response change was obtained at wharf 4 where the borehole was at the least distance away from the face of the nearest pile.

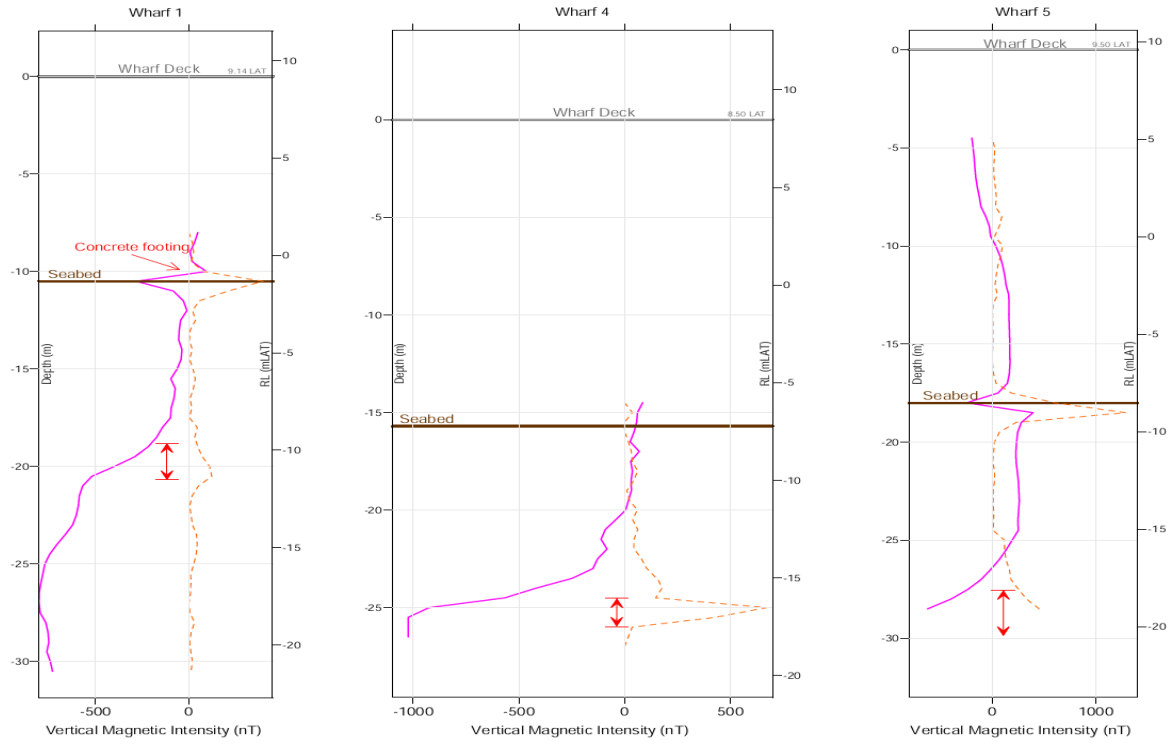


Figure 4. Results of downhole magnetics testing

The results of the borehole drilling and inferred pile toe levels at each borehole location based on interpretation of the downhole magnetics testing are summarized in Table 2.

Table 2. Summary of borehole and downhole magnetics investigation results

Borehole	Approx. distance to nearest existing pile (m)	Inferred pile toe level range[1] from magnetics testing (mLAT)	Materials recorded in borehole and SPT results
Wharf 1	1.4	-9.7 to -11.6 (-12.8)[2]	Gravelly Clayey Sand and Clayey Sand, SPT- N = 21 and 26 above -11.6 m LAT; SPT-N = 39 at -12.8 m LAT
Wharf 4	1.3	-15.0 to -17.4	Gravelly Sand and Clayey Gravelly Sand (Residual Soil); SPT-N = "R" (30 blows per 145 mm penetration)
Wharf 5	1.6	Below -18.1	Sandy Gravelly Clay and Sandy Gravel; SPT-N = "R" (30 blows per 100 mm penetration)

[1]Definitive levels cannot be inferred due to attenuation of magnetic intensity with distance away from the pile, and potential influence from other piles that have different toe levels.

[2]Based on SPT-N value, it is unlikely that the pile would have terminated in SP-N of 21 to 26 material. Therefore, the next SPT of N = 39 at 22 m depth (-12.8 mLAT) is considered to be a more reasonable estimate

Case study

An innovative method of assessing the capacity of existing wharf piles, Australia (Con't)

Test pile and CAPWAP analysis

The proposed methodology of testing originally proposed was that the test piles should have been installed to a similar pile toe level as assessed by the magnetics testing. However, due to logistics reasons, the test piles were installed before the magnetics testing took place, and they were generally driven to a level lower than the pile toe levels inferred from the magnetics testing.

The test piles comprised 457 mm OD steel tubular piles with a wall thickness of 15.9 mm, and they were driven using a Junttan HHK7A hammer. The average final sets under a final drop height of 1.2 m and the corresponding materials at the end of drive toe level from the nearest boreholes are tabulated in Table 3 and the CAPWAP analysis results of the test piles are summarized in Table 4.

Table 3. Test pile average final set and founding material

Test Pile	Installed pile toe Level (mLAT)	Average final Set (mm/blow)	Founding material inferred from the nearest boreholes
TP1 – Wharf 1	-16.553	1.6	Clayey Sandy Gravel, Residual Soil, SPT-N = "R" (30 blows / 60 mm penetration)
TP4 – Wharf 4	-17.558	2.1	Extremely Weathered Rock, SPT-N = "R" (30 blows / 60 mm penetration)
TP5 – Wharf 5	-19.169	2.2	Sandy Gravel, SPT-N = "R" (30 blows / 100 mm penetration)

Table 4. Results of test pile CAPWAP analysis

Test pile	Inferred EOD capacity (kN)[1]			Inferred restrike capacity (kN)[2]		
	Shaft	Toe	Total	Shaft	Toe	Total
TP1 – Wharf 1	-	-	-	2273	2685	4958
TP4 – Wharf 4	1674	2053	3727	1716	2304	4020
TP5 – Wharf 5	2169	2385	4554	1984	2338	4332

It can be seen from Table 4 that the test pile capacities are sufficiently high (even after accounting for geotechnical strength reduction and tension to compression reduction factors) to deal with the increased loads associated with the wharf upgrade work. However, because the test piles are driven into rock and founded below the existing pile toe levels inferred from the downhole magnetics testing, direct application of the dynamic pile load testing to assess the existing pile capacities was not possible. Further assessment of the pile capacities by correlation of shaft friction and end bearing capacities for the soil and rock layers intersected by the boreholes was necessary as discussed in the following section.

Assessment of existing pile capacities

As a cautious approach, an assumption was made to assess the situation where the pile toes of the existing piles are not founded into or close to rock level. The assessment was made as follows:

- Assume the pile toe is located at the average of the range assessed by the magnetics testing, or the best estimate for TP1 as shown in Note 2 of Table 2.
- For driven steel tubular piles, the phenomenon of "friction fatigue" as described by White and Lehane (2004) results in the pile shaft capacity mainly derived from about 10 x pile diameters (i.e. say 4.5 m) above the pile toe. This is the section where adjustment of SPT-N value and shaft capacity will take place. The ultimate shaft friction in this section were back-analysed from the CAPWAP results using the correlation of SPT-N values by DeCourt (1982) who suggested $f_S = K_S N + 10$ (kPa) where K_S is typically about 3.3 for displacement piles, although this was later reduced to 2.8 in Decourt (1995). Based on the CAPWAP results, however, we inferred a K_S value of about 3.4 at this site as shown in Figure 5.

Case study

An innovative method of assessing the capacity of existing wharf piles, Australia (Con't)

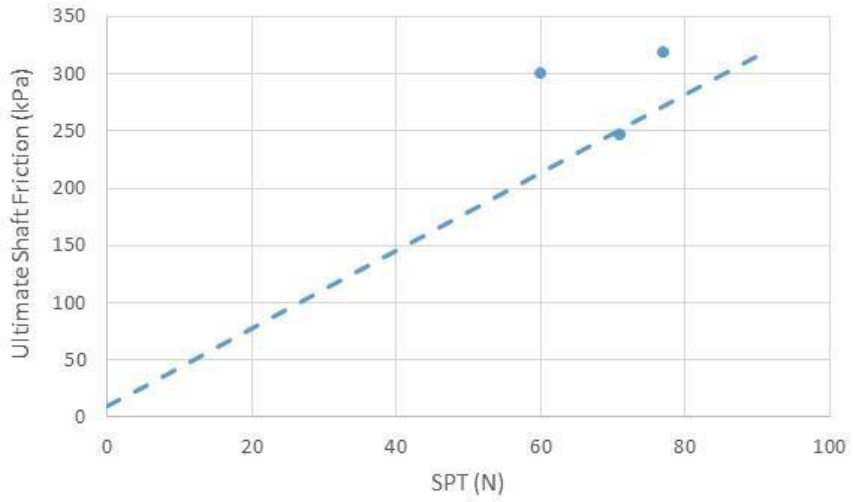


Figure 5. Back-analysed Relationship between Ultimate Shaft Friction and SPT-N

- For the shaft above 4.5 m above the test pile toe, the shaft friction from the CAPWAP testing was relatively low, and based on the SPT results, average values of 28 kPa to 45 kPa was adopted for the pile assessment for the upper part of the pile shaft, ignoring any shaft friction in soft to firm soils
- For the ultimate end bearing pressure, the CAPWAP results were back-analysed using the correlation of SPT-N values by Decourt (1982) who suggested $f_b = K_b N$ (kPa) for driven piles where K_b = 250 for sandy silt and 400 for sands, although the value for sands was later reduced to 325 for sands in Decourt (1995). From the test results, we adopted a correlation of $f_b = 300\ N^{0.77}$ as shown in Figure 6. This relationship was then applied to the inferred existing pile toe levels where SPT values may be lower than those below the toes of the test piles.
- Finally, reduction factors, ϕ_g and R_{st} as described in Section 1 above were applied to compute the design ultimate pile capacity presented in Table 5.

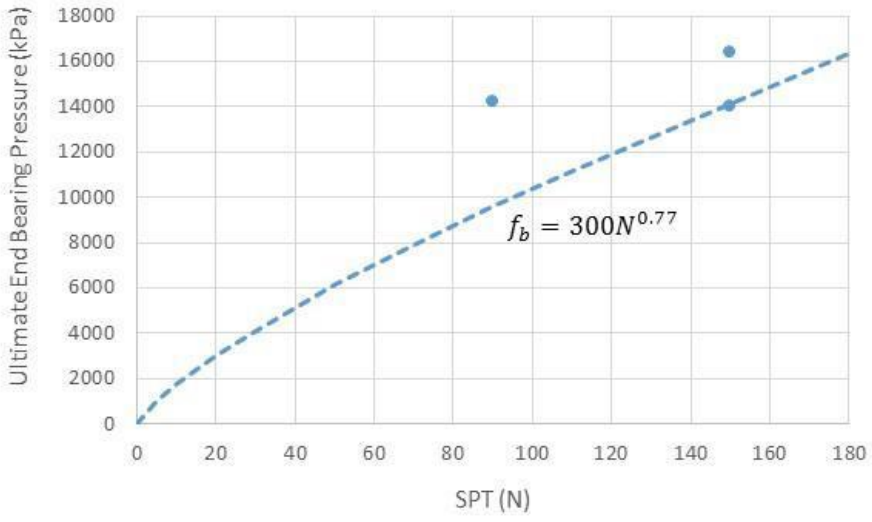


Figure 6. Back-analysed relationship between ultimate end bearing pressure and SPT-N

Case study

An innovative method of assessing the capacity of existing wharf piles, Australia (Con't)

Table 5. Pile capacity assessment results

Statistics	Wharf 1	Wharf 4	Wharf 5
Length of bottom 4.5 m	4.5	4.5	4.5
Length of upper pile shaft	5.5	3.2	4.5
Ultimate End Bearing Pressure (kPa)	4255	5804	6514
Ultimate Compression Shaft Friction in upper section of pile shaft (kPa)	28	34	45
Ultimate Compression Shaft Friction in bottom 4.5 m of pile shaft (kPa)	120	185	202
Assessed Ultimate Shaft Compression Capacity (kN)	997	1351	2382[1]
Assessed Ultimate Compression Base Capacity (kN)	698	952	5116[1]
Assessed Ultimate Compression Pile Capacity (kN)	1695	2304	7498[1]
Assessed Design Ultimate Compression Capacity (kN)[2]	1187	1613	5249[1]
Assessed Design Ultimate Tension Capacity (kN)[2]	419	568	1000[1]

[1]Based on 1,000 mm diameter existing pile at Wharf 5. Pile diameter = 457 mm for all other piles
[2]Design ultimate values including a ϕ_g value of 0.7 and a R_{st} ratio of 0.6 for tension capacity

Based on the assessment results shown in Table 5, only the wharf 1 Row D piles were found to have design ultimate capacities slightly less than the required capacity of 1364 kN for compression and 426 kN in tension. Following a review of the results with the marine/structural engineer for the project, it was considered that the existing piles are considered to be acceptable based on the following reason:

- The test piles were installed off the existing wharf and therefore slightly more seawards compared to the existing piles and the boreholes which were drilled from the wharf decks. Therefore, it is feasible that the bedrock is slightly deeper at the test pile locations compared to the existing piles which may also have been driven to rock.
- The downhole magnetics testing may be influenced by other piles further in-shore and which are shorter due to shallower depth to bedrock.
- The ultimate static end bearing capacity of the test piles are likely to be higher than those inferred from the dynamic pile load testing because during dynamic testing, the steel tubular pile will behave in an "unplugged" manner. Under static loading conditions, the steel tubular pile is likely to behave in a "plugged" manner thereby giving a much greater end bearing area.
- The inferred ultimate shaft capacity of the test piles will provide a reasonable estimate of the lower-bound unit shaft resistance of existing piles because the piles would not have sufficient time to "set up" with the restrike testing conducted only 24 to 48 hrs after end of drive. Furthermore, minor rusting/aging of the steel surface over time has been shown to increase the ultimate shaft resistance of tubular piles.
- As a result, no remedial works were deemed to be required for the proposed wharf upgrade works.

Conclusions

The innovative approach of combining conventional investigations with geophysical techniques using downhole magnetics testing, and dynamic pile load testing has enabled the toe levels of existing wharf piles to be assessed. Through the interpretation of unit shaft and base resistance derived from the test piles and adjustments made according to standard penetration test values at the inferred pile toe levels, the capacity of the existing piles was able to be made and compared to the increased load requirements associated with the wharf upgrade. In doing so, the existing piles were assessed to have adequate capacity and successfully avoided the costly option of remedial works for the client.

Case study

An innovative method of assessing the capacity of existing wharf piles, Australia (Con't)

Acknowledgements
The authors are grateful to NQBP for their permission to publish the test data in this paper. We are thankful to Royal Haskoning DHV (marine/structural engineers for the project) for their valuable comments on the pile assessment interpretation and content of the paper.

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TC corner

The 1st forum on the development of TC305: Geotechnical Infrastructure of Megacities and New Capitals

The first forum between the L.N. Gumilyov Eurasian National University (ENU) and the Incheon National University (INU) was held at the L.N. Gumilyov ENU on the Development of Geotechnical Infrastructure of Megacities and New Capitals TC305 (ISSMGE) on February 24-26, 2019 in Astana (Kazakhstan).

At the opening ceremony (Figure 1) of the forum, the first vice-rector (vice-rector for Academic Affairs) of ENU, Prof. Assemgul Moldazhanova, expressed in her speech about the importance of integration between INU and ENU, especially in terms of educational and research programs of graduate school. Prof. Ju Moon Park, dean of College of Urban Sciences of INU, also emphasized the importance of cooperation between ENU and INU. He introduced other INU's successful experiences of educational and research exchanges programs including the double-degree master's educational programs with European universities and wishes to establish master's dual degree program with L.N. Gumilyov ENU.

Figure 1. At the opening ceremony of the first forum between L.N. Gumilyov ENU and INU

Prof. Askar Zhussupbekov delivered in his welcoming speech about the history of collaboration between the Kazakhstan Geotechnical Society and the Korean Geotechnical Society.

As a special guest of the first ENU-INU forum, Mr. Kim Daesik, who is an Ambassador Extraordinary and Plenipotentiary of the Republic of Korea to the Republic of Kazakhstan H.E., gave a congratulatory speech.

A keynote lecture (Figure 2) was delivered by Vice-President for Asia of ISSMGE, Prof. Eun Chul Shin (Department of Civil and Environment Engineering, INU). The technical sessions were devoted to general issues on the development of urban infrastructure.

TC corner

The 1st forum on the development of TC305: Geotechnical Infrastructure of Megacities and New Capitals (Con't)

Figure 2. Keynote lecture of Prof. Eun Chul Shin on Educational Program for Future City Design Project

The Korean delegates delivered the following scientific reports: (1) Factors affecting the satisfaction of emergency medical services in capital and non-capital areas (Prof. Ju Moon Park (Figure 3); (2) Spatial Information (GIS) based future smart city construction (Prof. Byoung Gil Choi); (3) Vegetation Analysis in the Western part of South Korea using Open Source QGIS toolkit (Prof. Yong Chang Lee); (4) An influence of weather factors on the work loss days of the elderly workers in Korea (Prof. Chansik Lee); (5) Development of modern architecture in Pyeongyang (Associate Prof. Eungee Cinn); (6) Development of LRFD of displacement piles in frictional soils (Associate Prof. Dongwook Kim).

Figure 3. Invited lecture of Prof. Ju Moon Park from INU

TC corner

The 1st forum on the development of TC305: Geotechnical Infrastructure of Megacities and New Capitals (Con't)

On behalf of the Kazakhstan Geotechnical Society, the PhD students and Civil Engineering department academicians presented their reports in the technical session 2.

Associate Prof. Assel Sarsembayeva introduced her research results on moisture mass transfer in unsaturated freezing soils; Mrs. Nurgul Shakirova discussed about experience of application on LRT project in Astana the low strain method and cross-hole sonic logging for checking integrity of bored piles; Mr. Sungat Akhazhanov presented the geoinformation database for installation of driving and boring piles in Astana which used in construction site; Mrs. Gulshat Tleulenova reported about frost heaving during freezing and thawing of soils.

The MOU between INU and L.N. Gumilyov ENU was signed at the forum for realizing of joint double-diploma educational postgraduate program in Architecture and Civil Engineering (Figure 4). Prof. Baubek Somzhurek, vice-rector for International Relations and Innovations of ENU, and Prof. Ju Moon Park, dean of College of Urban Sciences of INU signed the MOU. The parties exchanged MOU documents and outlined a plan for implementation step by step of this educational program.

Figure 4. The MOU signing ceremony on the implementation of double-diploma postgraduate educational program

TC corner

The 1st forum on the development of TC305: Geotechnical Infrastructure of Megacities and New Capitals (Con't)

The director of ENU-lab Dr. Rauan Lukpanov, together with colleagues of the Departments of Design of Buildings and Structures and Technology of Industrial and Civil Engineering, conducted a technical tour at the laboratories and showed to the delegates' the current activities of ENU-lab (Figure 5).

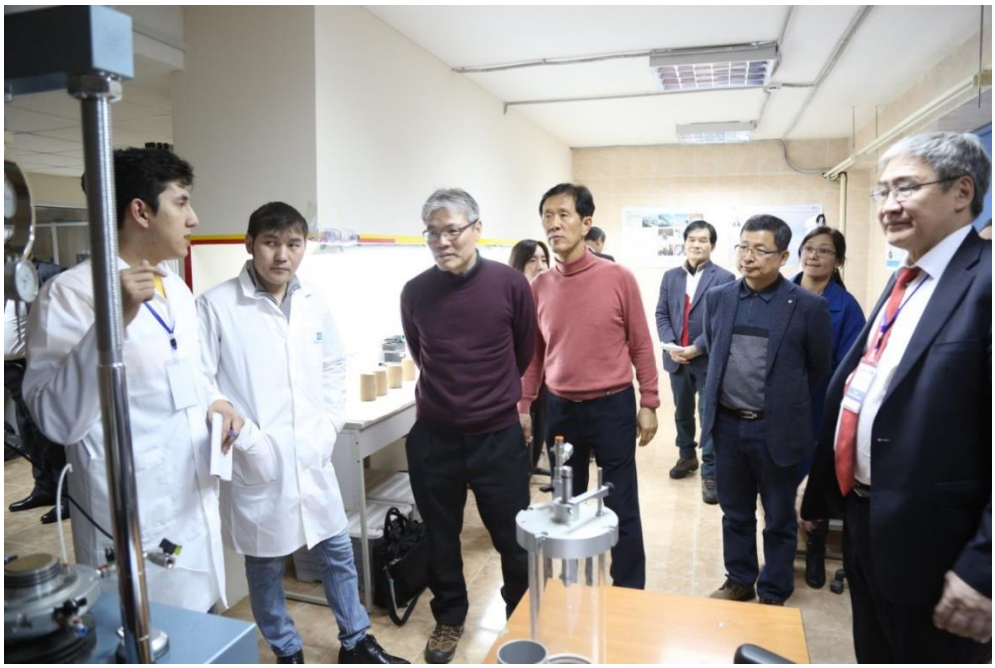

Figure 5. Technical tour to the ENU-lab

Within the forum program the technical tour took place at the Astanamasterplan, LLP and also delegates visited during city excursion the unique objects of Astana city (Figure 6).

Figure 6. Forum's Delegates in Astanamasterplan, LLP

Conference reports

The 17th National Soil Mechanics and Geotechnical Engineering Conference, Turkey, 2018

Turkish National Soil Mechanics and Geotechnical Engineering Conferences are organized biennially since 1981. These conferences are organized by the Geotechnical Divisions in Civil Engineering Departments under the auspices of the Turkish Soil Mechanics and Geotechnical Engineering Society.

The 17th National Conference was organized in Istanbul by Istanbul University-Cerrahpasa, Civil Engineering Department between 26-28 September 2018. The conference was chaired by Prof. Feyza Cinicioglu, and the conference coordinator was Prof. Ilknur Bozbey. The conference received intensive support and interest from Turkish professional community and was a great success with about 400 attendees.

The conference hosted two international invited speakers, Prof. Charles Wang-Ng, the President of the ISSMGE from Hong Hong University of Science and Technology and Professor Prof. Misko Cubrinovski from University of Canterbury. The invited lectures given in the honor of Prof. Hamdi Peynircioglu (the first chairman of the Turkish Geotechnical Society) were delivered by Prof. Gokhan Baykal and Prof. Mehmet Berilgen.

In the conference, 120 papers were presented by their authors. Three guided sessions were organized in which twelve invited speakers made valuable contributions. A special session was held as an award ceremony for the members of the Turkish Soil Mechanics and Geotechnical Engineering Society, who have been in the profession for 40 years. A session was organized for the Platin Sponsors of the conference. The details of the conference content are given below.

The next national conference will be hosted by Erciyes University in Kayseri (in Central Turkey) in 2020. The Turkish Society is proud of these national conferences which have served as a strong connection between the members of the society.

Ord. Prof. -Ing. A. Hamdi Peynircioglu Honorary Lectures

- *Prof. Gökhan Baykal*: "Innovation in Geotechnical Engineering"
- *Prof. Mehmet M. Berilgen*: "Modelling in Geotechnical Engineering"

Invited speakers

- *Prof. Charles W. Wang Ng, H. Lu, K. S. Y. Peng*: "Effects of stress relief due to deep excavation and twin tunneling on the capacity and deformation of floating piles"
- *Prof. Misco Cubrinovski*: "Key observations and findings on impacts of liquefaction in the 2010-2011 Christchurch earthquakes"

Guided sessions

- *Sadik Oztoprak, Orhan. E. Inanır, S. Banu. Ikizler, Nejan Huvaj*: "Geotechnical Site Characterization"
- *Ahmet Saglamer, Ozcan Tan, Ozer Cinicioglu, M. Kubilay Kelesoglu*: "Rigid inclusions and piled rafts: Advantages and disadvantages"
- *Kutay Ozaydın, K. Onder Cetin, M. Murat. Monkul, Pelin Ozener*: "A new era for Turkish Geotechnical Engineers: Turkish Building Earthquake Code, 2018"

Conference reports

The 17th National Soil Mechanics and Geotechnical Engineering Conference, Turkey, 2018 (Con't)

Figure 1. Prof. Charles Ng, the President of ISSMGE made two speeches; in the opening ceremony and as an invited speaker

Figure 2. The honorary lectures given in the honor of Prof. Hamdi Peynircioglu were delivered by Prof. Mehmet Berilgen and Prof. Gokhan Baykal

Figure 3. 17th Soil Mechanics and Geotechnical Engineering Conference was organized by the faculty and research assistants in Istanbul University-Cerrahpasa, Civil Engineering Department, Geotechnical Division (from left to right; Sinan Sargin, Tugce Cinar, Dr. Cihan Oser, Associate Prof. Sadik Oztoprak, Prof. Feyza Cinicioglu, Prof. Ilknur Bozbey, Dr. Zulal Akbay Arama, Associate Prof. Kubilay Kelesoglu)

Conference reports

The 1st Symposium on Geotechnical engineering and the dams "problems and solutions", Iraqi

The Iraqi Scientific Society of Soil Mechanics and Foundation Engineering held the 1st symposium at Ninavah governorate in cooperation with Civil Engineering Department/Al-Mosul University and the directorate of Mosul dam for two days from 13-14/3/2019. The symposium was held under the title of (Geotechnical Engineering and Earth Dams: Problems and Solutions). More than 120 members of the society attended this important symposium. This symposium was devoted to investigate worries over Mosul dam. The program of the 1st day included three sessions, the first session started with speech of Prof. Dr. Qusay Al Ahmadi / President of University of Al-Mosul followed by speech of Dr. Mahdi O. Karkush/President of the Iraqi Scientific Society of Soil Mechanics and Foundation Engineering. Then followed by a presentation about Mosul Dam presented by the expert Eng. Riyadh Al-Naemi/Mosul Dam Manger.

The second and third sessions included presentation of nine papers related to the behavior of gypseous rocks, dissolution of gypsum and anhydrite, and effect of dynamic loads on dams. The three sessions continued from 10 to 1:30 PM. Since Mosul city is located near one of the largest earth dams, Mosul Dam, and since most of the problems in the earth dams are considered very interested for geotechnical engineers, so the second day of symposium devoted to visit the Mosul dam by the society members and this day includes five presentations about the renovation of the dam, the geological of the dam, the grouting mechanism with the devices used and the new technology used in grouting. A lot of useful information and details are illustrated by the engineers and the experts of the dam. After this session the recommendations of the symposium were Announced. The members of society visited the grouting tunnel and examine the operating of grouting and mechanism with many practical details by the engineers was presented. Free tour to the reservoir of the dam and saw the amazing view and visited the outside grouting machines. Assembly photo in front of the administration building of Mosul earth dam is shown in Figure 1.

Figure 1: Assembly picture at the Mosul earth dam.

Conference reports

The 1st Symposium on Geotechnical engineering and the dams "problems and solutions", Iraqi (Con't)

Mosul dam was planned in 1950 to 1978, the geological investigation of Mosul earth dam continued by specialized companies to survey wide area in the north of Iraq. The last of which was a Swiss company approved the possibility of establishing the dam in its current area under a strict condition of a very intensive monitoring of the solubility of gypsum and anhydrite which could causes any defect in the foundations of dam. This should be followed by an immediate and quick treatment by cement/bentonite grouting. Hence, the grouting was planned to continue with the design life of the Mosul earth dam. The reason for this decision is the geology of the dam site which composed mainly of a highly variable strata of sedimentary rock consist of a highly soluble rocks of gypsum and anhydrite, with stratified layers of marl, and limestone. The present of such stratum in the foundation of hydraulic structure make the foundation becomes somewhat sensitive and require a continuous follow-up and raises the worries about the stability of the dam concerning the safety and performance.

The construction of dam started on 29/1/1981 and finished on 24/7/1986. Mosul dam is a large earth dam of length 3600 m and maximum height of 113 m. The full capacity of the dam is 11.11 billion cubic meters at a level of 330 m.a.s.l and the area of storage lake is 420 km^2. The elevation of top crest of the dam is 341.8 m.a.s.l. The current storage of the dam is 8 billion cubic meter and the height of water surface in storage lake is 322 m above the sea level. This dam designed for multi functions: storage of water, prevent the risk of flooding the cities in the downstream, producing electricity, and recreational area. The dam was designed with a more than 100 m depth grouting curtain located in the central longitudinal axis of the dam. The location of Mosul dam is shown in Figure 2.

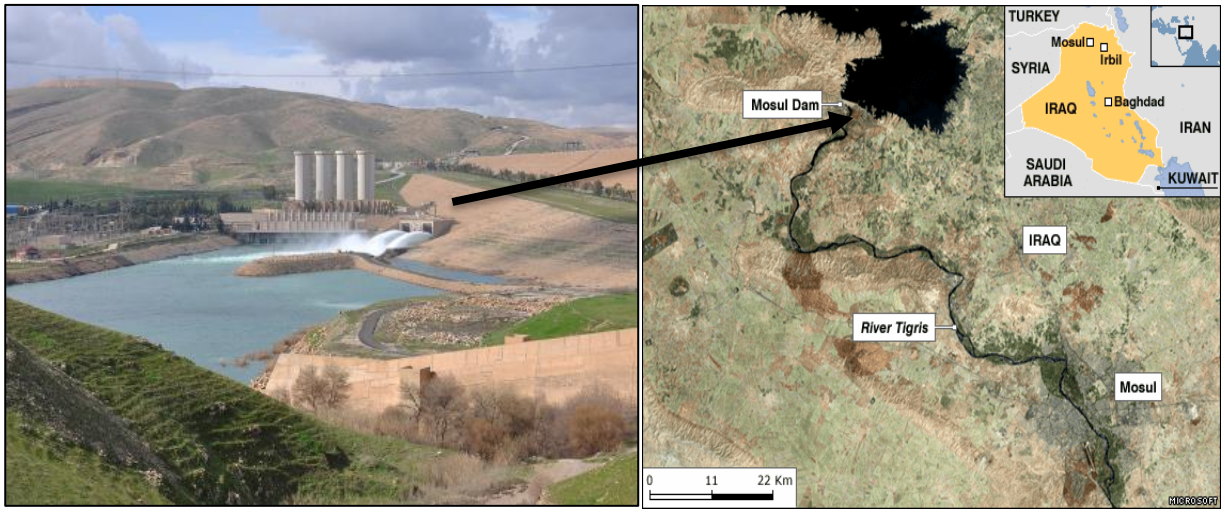

Figure 2: Location of the Mosul dam

The Mosul dam was constructed on highly variable strata which consist of gypsum, anhydrite, marl, and limestone, each of which is soluble in water under the hydraulic conditions of the dam at a faster rate than natural geologic processes. The presence of such stratum in the foundation of hydraulic structure make the foundation is very poor and raises the worries about the stability of the dam concerning the safety and performance. Increasing the storage capacity of the dam will increase the weakness of the dam foundation resulted from the dissolution of gypsum, anhydrite, marl, and limestone. A mineralogic variability within rock units resulted from original depositional processes that created interfaces and zones of weakness within individual beds, the geological strata under the dam are shown in Figure 3.

Conference reports

The 1st Symposium on Geotechnical engineering and the dams "problems and solutions", Iraqi (Con't)

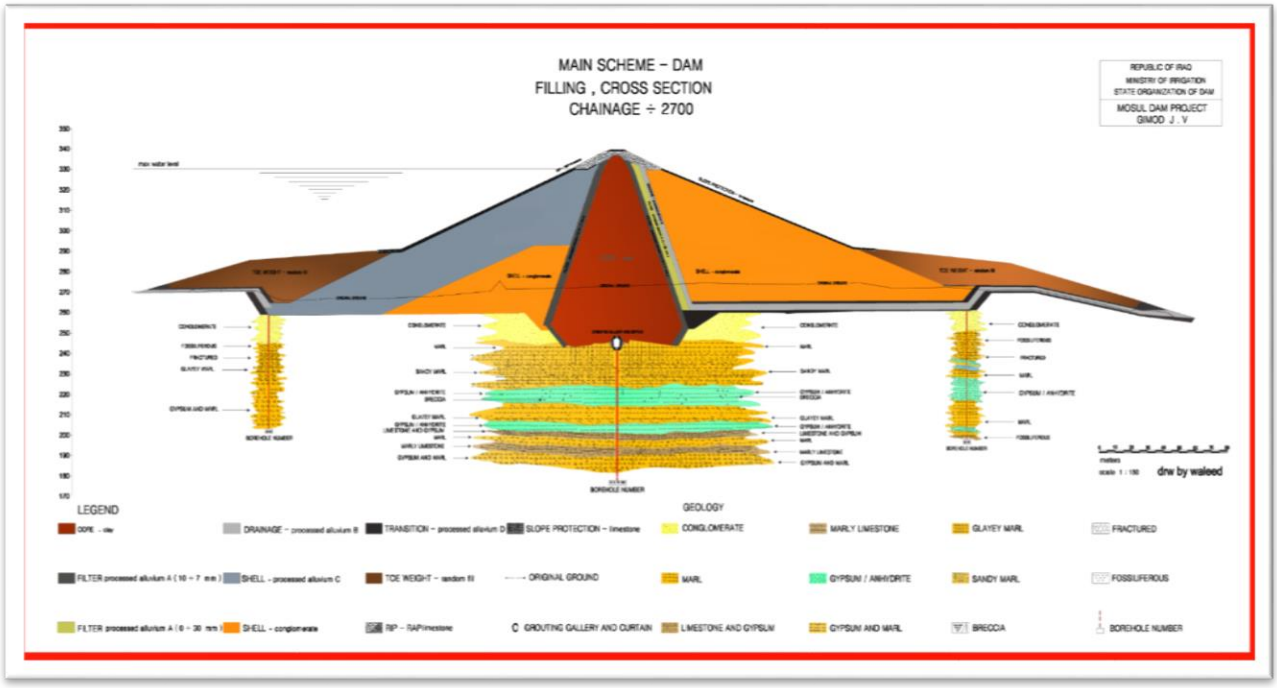

Figure 3: Geological strata of Mosul dam

The dam suffered from a delay in conducting the grouting operations because of the conditions experienced by the country and the most recent one was the occupation of the dam area by ISIS in 2014. This was accompanied by the presence of a few numbers of relatively old instrumentations of monitoring and surveillance sensors. One of these serious problems was takes place four years ago, sinkholes have reached the surface on the east abutment indicated a large-scale dissolution in the subsurface. The Iraqi staff of Mosul dam enabled from treating this big problem by dropping rocks of large diameter made in chain form inside the sinkholes and then covered with concrete.

The problem of the dam foundation can be controlled with continuous grouting. The grouting process did not attract the attention of specialists and political decision makers after 2003 and especially during the year 2014 due to the security situations in Mosul, therefore, the problem of dissolution of gypsum rocks increased rapidly. After that, the effort of political Iraq government supported by the US Army Corps of Engineers focused on this problem in 2016 and awarded the work of evaluating the hydraulic situation and performance of the dam to an Italian company. This company started the work immediately by collecting geological and hydrological data and put a plan to continue the grouting process and monitoring the foundation of the dam by installing different types of instruments used to measure the hydraulic head, cavitation, rate of gypsum rocks dissolution and vertical settlement of the dam. Nowadays, there are more than 1500 instruments and sensors installed in different locations of the dam for monitoring the hydraulic and geological conditions of dam. The grouting process is continuous for 24 hrs./day, electrical rigs used in the tunnel inside the dam and diesel rigs are used in the open area as shown in Figure 4. A digital software is used to prepare the grouting mixture and injection process. Also, a photogrammetry technique is used to evaluate the efficiency of the grouting process. The grouting depth is increased from 100 m in 2000 to reach 150 m in 2019.

Conference reports

The 1st Symposium on Geotechnical engineering and the dams "problems and solutions", Iraqi (Con't)

Figure 4: Drilling inside the tunnel and on the body of Mosul earth dam.

Mahdi O. Karkush
President of Iraqi Scientific Society of Soil Mechanics and Foundation Engineering

Hot news

SPH Vienna 2019

SPH Vienna 2019

International symposium on SPH and other particle-based continuum methods and their applications in geomechanics

Venue: BOKU, Vienna, Austria

Date: 11th – 13th September 2019

Language: English

Description

Analysis and design in civil engineering is much dominated by the mesh-based numerical methods such as FEM. This dominance is being rivaled by the meshfree methods for problems with free surface flow, large deformation and discontinuous deformation. The first meshfree method is SPH (Smooth Particle Hydrodynamics. The last decades saw rapid development of numerous meshless methods, e.g. MPM (Material Particle Method), XFEM, PFEM (Particle Finite Element Method). Geomechanics with complex material behavior and problem setting offers an excellent playground for meshfree methods.

This workshop brings together scientists, software developers and engineers to take stock of the state-of-the-art of meshfree methods, assess their potential for geomechanics problems and look into future development trends. Although the workshop focuses on SPH and other particle based continuum methods and their application in geomechanics, other innovative numerical methods and applications are equally welcome.

Organizer

Prof. Wu W, Institute of Geotechnical Engineering, BOKU, Vienna, Austria

Contact Information

Institute of Geotechnical Engineering, BOKU,
Feistmantelstrasse 4,
1180 Vienna, Austria
Email: geotech@boku.ac.at

Website

https://sph-vienna.com/

Event Diary

ISSMGE EVENTS

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

2019

Prague Geotechnical Days 2019
Location: Czech Academy of Science, Czech Republic, Prague
Date: 13-05-2019 - 14-05-2019
Language: English
Organiser: Czech and Slovak Society for Soil Mechanics and Geotechnical Engineering, SG Geotechnika, Charles University - Faculty of Science
Contact person: David Mašín
Address: Charles University, Faculty of Science, Albertov 6
Phone: +420602384793
Email: david.masin@natur.cuni.cz
Website: http://www.issmge.cz/index.htm
Email: jana.frankovska@stuba.sk, david.masin@natur.cuni.cz, Zdenek.Sekyra@geotechnika.cz

4th International Conference "Transportation Soil Engineering in Cold Regions"
Location: St .Petersburg, Russia,
Date: 20-05-2019 - 23-05-2019
Language: English
Organiser: Emperor Alexander I Petersburg State Transport University
Contact person: Anastasiia Konon
Address: 9, Moskovsky av,
Phone: +7 (921) 795-58-57
Email: geotech@pgups.ru
Website: http://conf-geotech.wixsite.com/transoilcold2019

4th Bolivian International Congress on Deep Foundations,
Location: Marriot Hotel - Santa Cruz - Bolivia,
Date: 23-05-2019 - 25-05-2019
Languages: English/Spanish;
Organiser: INCOTEC S.A., SBMSIG , TC212 ISSMGE;
Contact person: Mario Terceros,
Phone: +591 77801701,
Fax: +591 3 3429525,
Email: math@incotec.cc,
Website: http://www.cfpb4.com

14th International Conference on Under-Ground Construction Prague 2019
Location: Clarion Congress Hotel Prague, Czech Republic
Date: 03-06-2019 - 05-06-2019
Languages: English & Czech (simultaneous translation provided)
Organiser: Czech Tunnelling Association, ITA-AITES
Contact person: Dr. Markéta Prušková
Address: Dělnická 12
Phone: +420 702 062 610
Email: pruskova@ita-aites.cz; ps2019@guarant.cz
Website: https://www.ucprague.com/

Event Diary (Con't)

Construction in Historical Cities: Problems and Solutions
Date: 06-06-2019 - 07-06-2019
Location: The House of Architects, Bolshaya Morskaya Street 52, Saint Petersburg, Russia ,
Languages: Russian + English
Organizer: TC 207 ISSMGE & Institute "Georeconstruction" (Saint Petersburg)
Contact person: Eugene Dubinin
Address: Institute "Georeconstruction", St Petersburg, Russia
Email: georeconstruction@gmail.com
Website: http://tc207ssi.org
Email: lisyuk@gmail.com

7 ICEGE 2019 - International Conference on Earthquake Geotechnical Engineering
Date: 17-06-2019 – 20-06-2019
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

IS-Glasgow 2019 – 7th International Symposium on Deformation Characteristics of Geomaterials
Location: Technology and Innovation Centre (TIC) of the University of Strathclyde, United Kingdom , Glasgow
Date: 26-06-2019 - 29-06-2019
Language: English
Organiser: TC101
Contact person: Katharine Houston, University of Strathclyde
Email: geomaterials-symposium2019@strath.ac.uk
Website: https://www.is-glasgow2019.org.uk

ISDCG 2019 – 7th International Symposium on Deformation Characteristics of Geomaterials
Date: 26-06-019 – 28-06-2019
Location: Technology and Innovation Centre (TIC) of the University of Strathclyde, Scotland, UK,
Language: English
Organizer: TC101
Website: *in construction*

7th Asia-Pacific Conference on Unsaturated Soils
Date: 23-08-2019 - 25-08-2019
Location: Nagoya Congress Center, Nagoya, Japan
Language: English
Organiser: Prof. Feng ZHANG - The Japanese Geotechnical Society. Supported by: TC106 Unsaturated Soils of ISSMGE
Contact person: Dr. Hiromasa Iwai (Technical Secretary)
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Website: https://www.jiban.or.jp/e/activities/events/20190823-25-seventh-asia-pacific-conference-on-unsaturated-soils/

Event Diary (Con't)

ECSMGE 2019 – XVII European Conference on Soil Mechanics and Geotechnical Engineering
Date: 01-09-2019 – 06-09-2019
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
Website: http://www.ecsmge-2019.com

3rd International Conference "Challenges in Geotechnical Engineering" CGE-2019
Date: 10-09-2019 - 13-09-2019
Location: University of Zielona Gora (Poland),
Language: English
Organiser: University of Zielona Gora (Poland) and Kyiv National University of Construction and Architecture (Ukraine)
Contact person: Co-Chairmen of the Organising Committee: Volodymyr Sakharov, Waldemar Szajna
Address: 1, Prof. Zygmunta Szafrana str
Fax: +48 (68) 328 47 23
Email: info@cgeconf.com
Website : http://www.cgeconf.com

International Symposium on Geotechnical Aspects of Heritage Structure
Date: 16-09-2019 - 18-09-2019
Location: IIT Madras, Chennai, India
Language: English
Organiser: National Centre for Safety of Heritage Structure of IIT Madras (NCSHS-IITM) and IGS-Chennai Chapter in collaboration with IGS-Trichy Chapter and Anna University under the aegis of Technical Committee (TC301) of International Society of Soil Mechanics and
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Email: subhadeep@iitm.ac.in
Website: http://www.igschennai.in/ISGHS2019
Email: isghs19chennai@gmail.com

1st Mediterranean Young Geotechnical Engineers Conference
Location: Kefaluka Resort Hotel, Bodrum, Mugla, Turkey
Dates: 23-09-2019 - 24-09-2019
Language: English
Organiser: Turkish Society for ISSMGE - ZMGM
Contact person: Altug Saygili
Address: Mugla Sıtkı Kocman University, Engineering Faculty, Department of Civil Engineering, Kotelki, Mugla, Turkey
Phone: +90 252 211 1942
Fax: +90 252 211 1912
Email: secretariat@mygec2019.org
Website: http://mygec2019.org

Event Diary (Con't)

27th European Young Geotechnical Engineers Conference
Location: Kefaluka Resort Hotel, Bodrum, Mugla, Turkey
Dates: 26-09-2019 - 27-09-2019
Language: English
Organiser: Turkish Society for ISSMGE - ZMGM
Contact person: Altug Saygili
Address: Mugla Sıtkı Kocman University, Engineering Faculty, Department of Civil Engineering, Kotekli, Mugla, Turkey
Phone: +90 252 211 1942
Fax: +90 252 211 1912

3rd International Conference on Information Technology in Geo-Engineering (3RD ICITG2019)
Date: 29-09-2019 - 02-10-2019
Location: Cultural Centre of Vila Flor, Guimarães, Portugal
Language: English
Organiser: University of Minho and Portuguese Geotechnical Society under the auspices of JTC2 of FedIGS)
Contact person: 3rd ICITG Secretariat
Address: University of Minho/ School of Engineering/ Civil Engineering Department, Campus de Azurem
Phone: (+ 351) 253 510 750
Fax: (+ 351) 253 510 217
Email: 3rd-icitg2019@civil.uminho.pt
Website: http://www.3rd-icitg2019.civil.uminho.pt/

XVII African Regional Conference on Soil Mechanics and Geotechnical Engineering
Date: 07-10-2019 – 10-10-2019
Location: Cape Town Convention Centre, South Africa
Language: English
Organiser: SAICE
Contact person: Dr Denis Kalumba
Email: denis.kalumba@uct.ac.za

XVI Asian Regional Conference on Soil Mechanics and Geotechnical Engineering
Date: 21-10-2019 – 25-10-2019
Location: Taipei, China
Contact person: 16th ARC Secretariat
Phone: 886-2-27988329 ext.35
Fax: 886-2-27986225 (fax)
Email: secretariat@16arc.org
Website: http://www.16arc.org

11ème Édition des Journées Africaines de la Géotechnique
Date: 21-10-2019 - 24-10-2019
Location: Niamey, Niger
Languages: French and English language
Organiser: CTGA and ALBTP
Website: http://www.ctgaafrique.org
Email: emk2cm@Yahoo.fr

Event Diary (Con't)

GEOMEAST 2019 International Congress and Exhibition
Location: Cairo Marriott Hotel, Zamalek, in front of the Great Nile, Corniche El-Nile, Egypt
Dates: 10-11-2019 - 14-11-2019
Language: English
Contact person: Amany El-Masry
Address: Nasr City
Phone: +201151885508
Email: info@geomeast2019.org; info@ssige.org
Website: https://geomeast.org/

XVI Panamerican Conference on Soil Mechanics and Geotechnical Engineering
Date: 18-11-2019 – 22-11-2019
Location: Cancun, Quintana Roo, Mexico
Organizer: SMIG
Phone: +(52) 1 55 5677-3730, +(52) 1 55 5679 3676
E-mail: support@panamerican2019mexico.com
Website: http://panamerican2019mexico.com

The 4th International Conference on Geotechnics for Sustainable Infrastructure Development
Location: National Convention Center (NCC), Hanoi, Vietnam,
Date: 28-11-2019 - 29-11-2019
Language: English
Organiser: Vietnamese Society for Soil Mechanics and Geotechnical Engineering (VSSMGE), FECON Corporation, Thuyloi University (TLU), and Kokusai Kogyo Co., Ltd (KKC, Japan)
Contact person: NGUYEN Tien Dung
Address: FECON, 15th Floor, CEO Tower, HH2-1 Lot, Me Tri Ha Urban Area, Pham Hung Street, Me Tri Ward, Nam Tu Liem District
Phone: +84 903 440 978
Email: secretariat@geotechn.vn
Website: https://geotechn.vn/

9th Asian Young Geotechnical Engineers Conference
Location: University of Engineering & Technology (UET) Lahore, Pakistan
Date: 05-12-2019 - 07-12-2019
Language: English
Organiser: Pakistan Geotechnical Engineering Society (PGES)
Contact person: Dr. Muhammad Irfan
Address: 54810 G.T. Road
Phone: +92 306 66 666 010
Email: 9AYGEC@uet.edu.pk;
Website: http://15icge-9aygec.uet.edu.pk/

15th International Conference on Geotechnical Engineering, and 9th Asian Young Geotechnical Engineers Conference
Location: Lahore, Pakistan,
Date: 05-12-2019 - 07-12-2019
Language: English
Organiser: Pakistan Geotechnical Engineering Society (PGES)
Contact person: Dr. Muhammad Irfan (for 15ICGE); Dr. Jahanzaib Israr (for 9AYGEC)
Address: Civil Engineering Department, UET Lahore, Pakistan
Phone: +92 306 66 666 010; +92 334 413 2808
Email: 15icge@uet.edu.pk , 9aygec@uet.edu.pk

Event Diary (Con't)

First Indian Symposium on Offshore Geotechnics
Date: 05-12-2019 - 06-12-2019
Location: School of Infrastructure, Khordha, India
Language: English
Organizer: Indian Institute of Technology Bhubaneswar and Institute of Engineering and Ocean Technology, ONGC
Contact person: Sumanta Haldar and Shantanu Patra
Address: School of Infrastructure
Phone: +916747136636
Email: isog2019@gmail.com
Website: https://sites.google.com/iitbbs.ac.in/isog2019

International Conference On Case Histories And Soil Properties
Date: 05-12-2019 - 06-12-2019
Location: Furama Riverfront Hotel, Singapore,
Language: English
Organiser: Geotechnical Society of Singapore
Contact person: Geotechnical Society of Singapore
Address: 1 Liang Seah Street #02-11
Email: geoss@cma.sg
Website: http://www.iccs2019.org
Email: geoss@cma.sg

2020

14th Baltic Sea Geotechnical Conference 2020
Date: 25-05-2020 - 27-05-2020
Location: Clarion Hotel Helsinki, Finland
Language: English
Organiser: Finnish Geotechnical Society
Contact person: Leena Korkiala-Tanttu
Email: leena.korkiala-tanttu@aalto.fi
Website: http://www.ril.fi/en/events/bsgc-2020.html
Email: ville.raassakka@ril.fi

18th NGM Nordic Geotechnical Meeting
Date: 25-05-2020 – 27-05-2020
Location: Helsinki, Finland
Contact person: Ville Raassakka
Email: ville.raassakka@ril.fi
Website : http://www.ril.fi/en/events/ngm-2020.html

XIII International Symposium on Landslides (13 ISL) - Cartagena 2020
Date: 15-06-2020 - 19-06-2020
Location: Hotel Las Américas, Cartagena, Colombia
Language: English
Organiser: Colombian Geotechnical Society
Contact person: Juan Montero Olarte
Address: Transversal 28B No. 37-47
Phone: 57 1 2694260
Email: isl2020@scg.org.co
Website: http://www.scg.org.co

Event Diary (Con't)

International Conference on Geotechnical Engineering Education
Location: Greece, Athens
Date: 24-06-2020 - 25-06-2020
Language: English
Organiser: TC306
Contact person: Marina Pantazidou
Email: gee2020athens@gmail.com
Website: https://www.gee2020.org

4th European Conference on Unsaturated Soils - Unsaturated Horizons
Location: Instituto Superior Técnico, Lisbon, Portugal,
Address: Av Rovisco Pais, 1
Date: 24-06-2020 - 26-06-2020
Language: English
Organiser: IST, TUDelft and UPC
Contact person: info@EUNSAT2020.tecnico.ulisboa.pt
Website: http://www.EUNSAT2020.tecnico.ulisboa.pt

TC204: Geotechnical Aspects of Underground Construction In Soft Ground - TC204 Cambridge 2020
Date: 29-06-2020 - 01-07-2020
Location: University of Cambridge, United Kingdom
Language: English
Organiser: University of Cambridge
Contact person: Dr Mohammed Elshafie
Address: Laing O'Rourke Centre, Department of Engineering, Cambridge University
Phone: +44(0) 1223 332780
Email: me254@cam.ac.uk

4th International Symposium on Frontiers in Offshore Geotechnics
Date: 16-08-2020 - 19-08-2020
Location: University of Texas, Austin, United States
Language: English
Organiser: ISFOG 2020 Organising Committee
Contact person: Phil Watson
Address: The University of Western Australia
Phone: 0418881280
Email: phillip.watson@uwa.edu.au
Website: http://www.isfog2020.org

6th International Conference on Geotechnical and Geophysical Site Characterization
Date: 07-09-2020 - 11-09-2020
Location: Budapest Congress Center, Hungary , Budapest
Language: English
Organizer: Hungarian Geotechnical Society
Contact person: Tamas Huszak
Address: Muegyetem rkp. 3.
Phone: 0036303239406
Email: huszak@mail.bme.hu
Website: http://www.isc6-budapest.com
Email: info@isc6-budapest.com

Event Diary (Con't)

3rd International Symposium on Coupled Phenomena in Environmental Geotechnics
Location: Kyoto University, Japan
Date: 29-10-2020 - 30-10-2020
Language:English
Organiser: TC215 (Environmental Geotechnics), Japanese Geotechnical Society (JGS), and Kyoto University
Contact person: Takeshi Katsumi
Address: Yoshida-honmachi
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Website: https://cpeg2020.org
Email: cpeg2020@geotech.gee.kyoto-u.ac.jp

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2nd International Intelligent Construction Technologies Group Conference
Date: 23-04-2019 - 25-04-2019
Location: Beijing Hotel, Beijing, China
Language: English and Mandarin
Organiser: International Intelligent Construction Technologies Group (IICTG)
Contact person: George Chang (President of IICTG)
Address: 6111 Balcones drive
Phone: 5124516233
Email: gkchang@TheTranstecGroup.com
Website: http://www.iictg.org/2019-conference/

Western Geotechnical Centrifuge Opening & Symposium 2019
Dates: 02-05-2019 - 03-05-2019
Location: Western University, London, Canada
Language: English
Contact person: Cynthia Quintus
Address: Geotechnical Research Centre, Spencer Engineering Building
Phone: +1-519-661-3344
Fax: +1-519-661-3942
Email: cquintus@uwo.ca; tnewson@eng.uwo.ca
Website: https://www.eng.uwo.ca/wgc/

6th International Course on Geotechnical and Structural Monitoring
Dates: 27-05-2019 - 31-05-2019
Location: Casa dell'Aviatore, Rome, Italy
Language: English
Contact person: NHAZCA Srl
Address: Via V. Bachelet, 12
Email: info@geotechnicalmonitoring.com
Website: https://www.geotechnicalmonitoring.eu/

Event Diary (Con't)

2nd International Conference on Natural Hazards and Infrastructure
Location: Minoa Palace Resort, Chania, Greece, Chania
Date: 23-06-2019 - 26-06-2019
Language: English
Organiser: The Innovation Center on Natural Hazards and Infrastructure
Contact person: Dr. Rallis Kourkoulis
Address: Efesou 15
Phone: +30 210 6721798
Email: secretary@iconhic.com
Website: https://iconhic.com/2019/

EUROCLAY, Paris 2019: Geotechnical characterisation of clayey geomaterials from micro to macroscale: the role of microstructure and anisotropy
Location: Pierre & Marie Curie University, Sorbonne Universités, Paris, France
Date: 01-07-2019 - 05-07-2019
Language: English
Organiser: French Clay Group (GFA), part of the European Clay Groups Association (ECGA)
Contact person: Prof. Philippe Cosenza
Email: philippe.cosenza@univ-poitiers.fr
Website: https://euroclay2019.sciencesconf.org
Email: euroclay2019@sciencesconf.org

International Symposium on SPH and Other Particle-Based Continuum Methods and their Applications in Geomechanics
Date: 11-09-2019 - 13-09-2019
Location: Institute of Geotechnical Engineering, BOKU, Vienna, Austria English
Organiser: Institute of Geotechnical Engineering, University of Natural Resources and Life Sciences Vienna (BOKU)
Contact person: Prof. Wei Wu
Address: Feistmantelstrasse 4
Phone: +4314765487300
Fax: +4314765487309
Email: geotech@boku.ac.at
Website: https://sph-vienna.com/

ISRM - 14th International Congress of Rock Mechanics
Location: Bourbon Cataratas Convention & Spa Resort, Foz do Iguassu, Brazi
Date: 13-09-2019 - 18-09-2019
Language: English
Organiser: ABMS, SAIG, SPG
Contact person: Sergio A. B. da Fontoura
Email: fontoura@puc-rio.br
Website: http://www.isrm2019.com

Event Diary (Con't)

12th Asian Regional Congress of IAEG
Location: Booyoung Jeju Hotel & Resort, South Korea , Seogwipo-si
Date: 21-09-2019 - 27-09-2019
Language: English
Organiser: The Korean Society of Engineering Geology and Korea national group of International Association of Engineering Geology and the Environment (IAEG
Contact person: Jen. Ryu
Address: 4F Officia BD, 92 Saemunan-ro
Phone: +82--3276-2206
Email: secretariat@iaegarc12.org
Website: http://www.iaegarc12.org/main/main.html

Canadian Geotechnical Society's Annual Conference
Location: St. John's Convention Centre in St. John's, Newfoundland and Labrador, Canada,
Date: 29-09-2019 - 02-10-2019
Organiser: Canadian Geotechnical Society
Contact person: Lisa McJunkin
Email: admin@cgs.ca
Website: http://www.geostjohns2019.ca
Email: sponsors@geostjohns2019.ca

DFI 44th Annual Conference on Deep Foundations
Dates: 15-10-2019 - 18-10-2019
Location: Hilton Chicago, United States
Organizer: Deep Foundations Institute
Contact person: Theresa Engler
Address: 326 Lafayette Avenue
Phone: 19734234030
Fax: 19734234031
Email: tengler@dfi.org; staff@dfi.org
Website: http://www.dfi.org

ReSyLAB & GEO-EXPO 2019 – Sarajevo, Bosnia and Herzegovina
Location: Sarajevo, Bosnia and Herzegovina
Date: 23-10-2019 - 25-10-2019
Languages: Bosnian, Croatian, Serbian and English
Organiser: Geotechnical Society of Bosnia and Herzegovina
Contact Information
Contact person: Sabrina Salkovic
Address: Univerzitetska 2, Tuzla 75000 Bosna i Hercegovina
Phone: + 387 61 451 701
Email: geotehnika@geotehnika.ba
Website: http://www.geotehnika.ba/

8th International Geotechnical Symposium
Date: 13-11-2019 - 15-11-2019
Location: Suleyman Demirel Kultur Merkezi, ITU Ayazaga Campus, Istanbul, Turkey
Language: English and Turkish
Organiser: UCTEA Turkish Chamber of Civil engineers, Istanbul Branch and Turkish Society for ISSMGE
Contact person: Kubilay Sahin
Email: bilimsel@geoteknik2019.org
Website: http://www.geoteknik2019.org

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2020

DFI Deep Mixing 2020
Dates: 15-06-2020 - 17-06-2020
Location: TBD, Gdansk, Poland
Organizer: Deep Foundations Institute
Contact person: Theresa Engler
Address: 326 Lafayette Avenue, Hawthorne, NJ 07506, USA
Phone: 19734234030
Fax: 19734234031
Email: tengler@dfi.org
Website: http://www.dfi.org
Email: staff@dfi.org

16th International Conference of the International Association for Computer Methods and Advances in Geomechanics - IACMAG
Location: Politecnico di Torino Conference Centre, Italy ,
Date: 29-06-2020 - 03-07-2020 English
Organiser: Politecnico di Torino
Contact person: Symposium srl
Address: via Gozzano 14
Phone: +390119211467
Email: info@symposium.it; marco.barla@polito.it

DFI 45th Annual Conference on Deep Foundations
Dates: 13-10-2020 - 16-10-2020
Location: Gaylord National Resort & Convention Center, Oxon Hill, MD, USA
Organizer: Deep Foundations Institute
Contact person: Theresa Engler
Address: 326 Lafayette Avenue, Hawthorne, NJ 07506, USA
Phone: 19734234030
Fax: 19734234031
Email: tengler@dfi.org
Website: http://www.dfi.org
Email: staff@dfi.org

Fifth World Landslide Forum
Dates: 02-11-2020 - 06-11-2020
Location: Kyoto International Conference Center, Kyoto, Japan
Organizer: International Consortium on Landslides
Contact person: Ryosuke Uzuoka
Address: Gokasho
Phone: +81-774-38-4090
Email: uzuoka.ryosuke.6z@kyoto-u.ac.jp
Website: http://wlf5.iplhq.org/
Email: secretariat@iclhq.org

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

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f. Chinese Taipei Geotechnical Society www.tgs.org.tw

g. Prof. Zuyu Chen
http://www.iwhr.com/zswwenglish/index.htm

h. East China Architectural Design and Research Institute ECADI
http://www.ecadi.com/en/

i. TC 211 of ISSMGE for Ground Improvement
www.bbri.be/go/tc211

j. Prof. Askar Zhussupbekov www.enu.kz/en, www.kgs-astana.kz

k. TC302 of ISSMGE for Forensic Geotechnical Engineering
http://www.issmge.org/en/technical-committees/impact-on-society/163-forensic-geotechnical-engineering

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