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GEOTECHNICAL ENGINEERING

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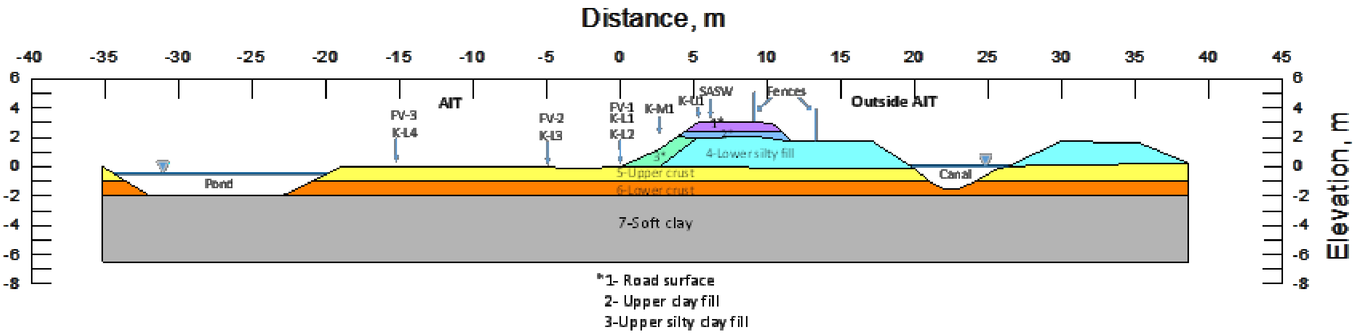
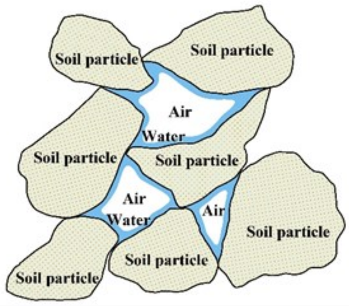
EDITORS: Eng-Choon Leong & Hossam Abuel-Naga

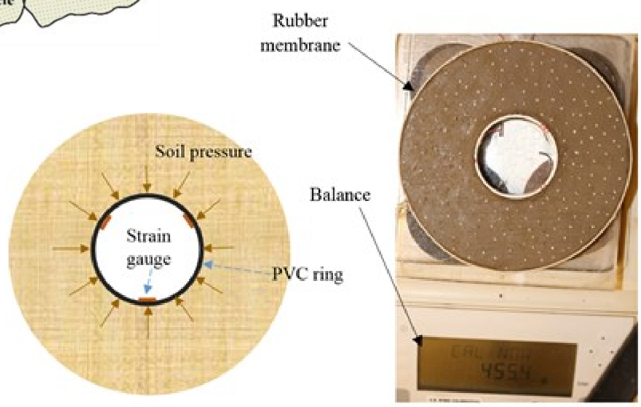


Cross-section of the instrumented AIT dyke (After Jotisankasa, Pramusandi, Nishimura and Chaiprakaikeow, 2019)

Triaxial cell of hollow cylinder torsional shear apparatus (After Toyota, Le and Takada, 2019)



Schematic microscopic state of unsaturated soil on particle scale (After Kitamura and Sako, 2019)



Soil specimen in retained ring test (After Al-Dakheeli and Bulut, 2019)

GEOTECHNICAL ENGINEERING

March 2019: Guest Editors

Edited by: Leong Eng Choon & Hossam Abuel-Naga

Leong Eng Choon is currently an Associate Professor at Nanyang Technological University, Singapore. He has over 30 years of teaching experience in geotechnical engineering and is an active researcher in unsaturated soils and soil dynamics. He has published more than 320 journal and conference papers. He is currently an editorial board member of several journals and is an active reviewer for many journals. He has won several awards, notably the Excellence in Reviewing for the Geomechanics for Energy and the Environment journal in 2018, the Koh Boon Hwee Mentor award in 2013, and the ASTM best paper award in 2006. He is also active in the national standardization programmes in SPRING, Singapore. He is the lead author and co-author of the books entitled "Guide to Research Projects for Engineering Students - Planning, Writing, Presenting" and "Mechanics of Residual Soils, 2nd Edition", respectively. He currently chairs the Technical Committee on Civil and Geotechnical Works and is the deputy chair for the Committee of Council of Inspection Bodies. Through the Technical Committee on Civil and Geotechnical Works, he oversees the development of the National Annexes for Eurocode 7 which is the standard for geotechnical design in Singapore from 1 April 2015. He has also won several awards for his work in the national standardization programmes. These include the SAC Assessor Bronze, Silver, Gold and Distinguished Awards in 2005, 2006, 2009, and 2010, respectively, and the SPRING Singapore Merit Awards in 2010 and 2017 for invaluable contributions to Quality and Standards. He is a registered Professional Engineer in Singapore and is also a senior member of Institution of Engineers Singapore, and member of Southeast Asian Geotechnical Society and American Society of Civil Engineers.

Hossam Abuel-Naga is the leader of Civil Engineering discipline at La Trobe University, Australia and Adjunct Professor at Chongqing University, China. Previously, he was Senior Lecturer and Leader of Geo-Engineering at The University of Manchester, UK; Senior lecturer at The University of Auckland, New Zealand; and Research fellow at Monash University, Australia. He has over 25-year experience in geotechnical engineering, specialising in soil behaviour under multi-physical coupled processes. Applications of this research area include nuclear waste disposal technology, methane hydrate mining technique, energy foundations, ground improvement, landfill lining system, and more. He served as a Reviewer/Panellist for several Research Funding Agencies including; National Science Foundation-USA, Australian Research Council, Swiss National Science Foundation, Portuguese Foundation for Science and Technology, Qatar National Research Fund, and HiCi, King Abdulaziz University, Kingdom of Saudi Arabia.

GEOTECHNICAL ENGINEERING

PREFACE

March 2019 Issue

This special issue on Unsaturated Soils: Testing, Modelling and Applications is edited by Eng-Choon Leong and Hossam Abuel-Naga as Guest Editors.

Unsaturated soils research has started at the same time from the beginning of soil mechanics as evidenced from the papers presented in the First International Conference on Soil Mechanics and Foundation Engineering in 1936 at Havard University, Cambridge, Massachusetts, USA. However, problems involving unsaturated soils were too difficult to solve at that time and interest waned. Since the late 1970s, increasing research has been performed on unsaturated soils mainly due to the advances in computer and data acquisition in testing. Advances in computer means that more powerful software could be developed to solve complicated problems. Aided by the advances in computer technology, data acquisition is now possible for long duration experiments which are required for unsaturated soil testing. There are 13 papers in this special issue covering testing, modelling and applications. Seven papers are on testing, three papers are on modelling and three papers are on applications.

The first two papers are on the soil-water retention curves. Soil-water retention curve is considered a basic property of unsaturated soils and the curve has been used to estimate the permeability function and shear strength of unsaturated soils. In the first paper on Water Retention Characteristics of Swelling Clays by Kannan K.R. Iyer and D.N. Singh, the effect of the initial state of soil (viz., slurried, intact or compacted state) on the soil-water retention characteristics (SWRC) and the unsaturated soil behaviour for swelling clays was investigated. Drying and wetting soil-water retention curves were obtained for intact and reconstituted specimens of swelling clays using a dewpoint potentiameter (WP4C) and environmental chamber. The study found that initial water content has a greater effect on the drying SWRC than the wetting SWRC. In addition, the drying SWRCs for intact and reconstituted specimens converge beyond certain stage of drying. They suggested that reconstituted specimens can be used for studying behaviour of intact clays in relatively dry state. The second paper on Water Retention and Unsaturated Hydraulic Behaviours of a Biochar-modified Silt by Abraham C.F. Chiu, B. Qiao and Y. Xiao investigated the effects of biochar content and void ratio on the water retention and unsaturated hydraulic behaviors of a biochar-modified silt for application as a soil cover of municipal solid waste landfill to mitigate methane emission. A rice straw derived biochar was used. The characteristics of biochar are high internal porosities and negative surface charge. Adding biochar to the silt creates more flocculated microstructures and the pore size distributions measured by the mercury intrusion porosimetry indicate that the biochar-modified silt contains more micro-porosities than the untreated silt. From modified evaporation test, increasing biochar content increases the water retention capacity of the biochar-modified silt. However, the biochar-modified silt shows a lower saturated permeability and also a lower rate of change in permeability with respect to suction. Although the biochar-modified silt is less permeable than the untreated silt in the low suction range, it becomes more permeable after drying in the high suction range. The findings may have implications on its application as a soil cover of municipal solid waste landfill to mitigate methane emission.

The third paper on Simplified Model for Heat Transfer in Unsaturated Soils Considering a Nonisothermal Thermal Conductivity Function by R. A. Samarakoon, and J. S. McCartney investigates a simplified model for heat transfer in unsaturated soils using a conduction analysis with a nonisothermal thermal conductivity function. In the model, a relationship between the apparent thermal conductivity and degree of saturation that indirectly incorporates the effects of heat transfer due to convection and water phase change through temperature effects was defined based on experimental observations, and the governing equation for conductive heat transfer was reconsidered to account for the variation in nonisothermal thermal conductivity with respect to space and time. The model performance was evaluated by comparing with a conventional isothermal conduction analysis and with temperatures measured from an experimental study on heat transfer in unsaturated silt. Good match was found in both cases showing that the simplified model may be used for preliminary analyses of problems involving monotonic heating.

In the fourth paper, A Simple Approach to Monitor Soil Moisture Dynamic in A Vapour Equilibrium Cell by Yi Lu, Zhi Shang, Hamayon Tokhi, and Hossam Abuel-Naga, a novel method of determining moisture equilibrium in vapour equilibrium technique was suggested. The method involves making electrical conductivity measurement of the soil specimen as it equilibrates in a desiccator where a salt solution was placed. In this method, sample disturbance is avoided and error caused by water condensation on the soil specimen is eliminated by housing the soil specimen in a PVC tube placed on its side in the desiccator.

The fifth paper is on A Classification Tree Guide to Soil-water Characteristic Curve Test for Soils with Bimodal Grain-size Distribution by L. Zou and E.C. Leong. Soils with bimodal grain-size distribution (GSD) can have a unimodal or bimodal soil-water characteristic curve (SWCC). It is important to know *a prior* if a SWCC is unimodal or bimodal as this will dictate the number of measurement points that is needed to correctly define the SWCC. Insufficient measurement points may cause a bimodal SWCC to be erroneously interpreted as a unimodal SWCC. In this paper, a classification tree is proposed to identify bimodal GSD soils with bimodal SWCC. The classification tree was developed using an extensive database of 226 bimodal GSD soils. The classification tree was evaluated using an independent data set consisting of 60 SWCCs and its performance compared with criteria proposed by others. The classification tree was shown to outperform the criteria proposed by others. This is a useful guide to better plan SWCC tests.

The sixth paper is on Backpressure Saturation Effects on the Mechanical Behaviour of a Quasi-Saturated Compacted Residual Soil by G.G. Carnero-Guzman and F.A.M. Marinho. This paper study the use of saturation methods in triaxial tests as it may influence negatively the test results. Two saturation methods in a residual soil from São Paulo, Brazil, compacted to wet of optimum, a quasi-saturated state, were investigated. Triaxial CIU tests were performed with fully saturated and quasi-saturated samples. It was found that both processes lead to different wetting paths and volumetric changes which influenced the pore-water pressure development and hence, the effective strength parameters.

The seventh paper is on Induced and Inherent Anisotropies of Saturated and Unsaturated Soil Shear Properties by H. Toyota, B. N. Le and S. Takada. Induced anisotropy is caused by anisotropic stresses whereas inherent anisotropy is caused by formation history of the soil. Induced anisotropy was induced in cohesive saturated and unsaturated specimens in a hollow cylinder torsional shear apparatus and the shear behavior was obtained for undrained shearing for the saturated soil and constant water content condition for unsaturated soil. Inherent anisotropy was induced in sand specimens by depositing the sand particles at different depositional angles by sedimentation. The shear properties under a drained condition for saturated sand and a constant suction condition for unsaturated sand were evaluated using the triaxial apparatus. The results indicate that anisotropic behaviour is evident for both the cohesive soil and the sand. However, for the cohesive soil, shear strength anisotropy is lesser for unsaturated condition compared to the saturated condition.

The eighth paper is on Modeling of Unsaturated Soil Aided by Probability and Statistics by R. Kitamura and K. Sako. In this paper, a microscopic mechanical model is proposed to analyze the various mechanical behaviors of unsaturated coarse-grain soil. The only physical quantities used in the proposed model are grain size distribution, soil particle density, void ratio and water content. Probability theory and inferential statistics are used to relate the macroscopic physical quantities used in the conventional soil mechanics to the microscopic physical quantities in the proposed model. This paper presents the basis of a more complex model which the authors are proposing in a book to be published.

The ninth paper is on Elastoplastic Modelling of Hydro-mechanical Behaviour of Unsaturated Soils by J.R. Zhang, D.A. Sun and W.J. Sun. Firstly, current state of development of constitutive models for unsaturated soils is briefly reviewed, and then the state of the art of elastoplastic constitutive models for unsaturated soils is summarized. The paper introduces an elastoplastic model where hydraulic and mechanical behaviour are coupled for unsaturated non-expansive and expansive soils. Hysteresis in the soil-water characteristic is modeled as an elastoplastic process with the elastic region of the degree of saturation. The model also considers the effect of degree of saturation on the stress-strain-strength behaviour and the change in void ratio on the soil-water characteristics curve in addition to the effect of suction on the hydraulic and mechanical behaviour. The model was shown to perform well with element test data.

The tenth paper is on Interpretation of Desiccation Soil Cracking in the Framework of Unsaturated Soil Mechanics by H. Al-Dakheeli and R. Bulut. Cracks are associated with drying and shrinkage in soils, more so in expansive in expansive soils. This paper provides understanding and modelling of soil cracking using unsaturated soil mechanics. Restricted shrinkage tests were carried out using restrained ring testing method to induce cracks in initially saturated soil specimens. The test results demonstrate that a crack first initiates at suction close to the air air-entry value, i.e., when the soil first becomes unsaturated. Free shrinkage tests were also conducted to predict the soil shrinkage curve. The results from restrained ring tests are explained in terms of the soil-water characteristic curve and soil shrinkage curve

The eleventh paper is on Field Response of an Instrumented Dyke subjected to Rainfall by A. Jotisankasa, S. Pramusandi, S. Nishimura and S. Chaiprakaikeow. This paper reports a field study of an instrumented dyke on soft Bangkok clay in Pathumthani, Thailand. Field characterization tests conducted includes dynamic cone penetration tests, field vane shear tests and Spectral Analysis of Surface Waves geophysical tests. The dyke was instrumented to monitor pore-water pressure, suction, moisture content and rainfall continuously over the rainy season in 2017. The upper 0.5 m of dyke was found to experience drastic changes in suction from 1800 kPa towards the end of a drought and abruptly reducing to 20-40 kPa within a day upon the onset of the rainy season. It was suggested that the large and abrupt changes in suction are likely to have aggravated the surface cracking and hence the dyke movements. At 3 m depth from the dyke shoulder, no influence to the short-term rainfalls was visible. The vertical movement of the dyke surface was attributed to the combined effects of drying, collapse-on-wetting and swelling where some movement is recoverable. However, this was not the case for horizontal movements which showed constant outwards cumulative displacement.

The twelfth paper is on Simplified Shear Deformation Method for Analysis of Mechanical Behavior of Pile Foundations in Expansive Soils by Y. Liu and S.K. Vanapalli. In this paper, the seasonal volume changes in expansive soils associated with wetting and drying conditions due to infiltration and evaporation of water were examined for the load transfer mechanism from pile to soil. It is proposed to modify the conventional shear deformation method to account for the influence of infiltration and evaporation of water for the load transfer in a single pile. Parametric analyses were also conducted and pile diameter and pile length were found to significantly influence the mechanical behaviour of piles in expansive soils. It is suggested that the proposed method can be used in the routine design of foundations for expansive soils.

The thirteenth paper is on Validation of Foundation Design Method on Expansive Soils by K.C. Chao and J.D. Nelson. This paper presents a method to validate the foundation design method proposed in Nelson et al. (2015). The validation data used was obtained from long term monitoring of a building constructed on expansive soils at the Denver International Airport, Denver, Colorado, USA, where consttuction was completed in 1991. Water migration in the vadose zone and heave of floor slabs and drilled pier foundations were monitored from 2000 to 2016. Water content profiles were modeled using VADOSE/W software, and heave of slabs and piers were computed using the design method proposed in Nelson et al. (2015). Comparison of calculated and measured heaves showed that the predicted heave is within 30 percent of the measured heave over a 25-year period, from end of construction to 2016.

ACKNOWLEDGEMENT

Thirteen papers are contained in this issue. No doubt the material contained herein would be most valuable to our profession. The editors have adequately described the contributions in the preface. They are to be congratulated for these contributions.

Dr. Teik Aun Ooi
Prof. San Shyan Lin
Prof. Kwet Yew Yong
Dr. Noppadol Phienwej
Prof. A. S. Balasubramaniam

GEOTECHNICAL ENGINEERING

March 2019: Special Issue in Unsaturated Soils – Testing, Modelling and Applications

Edited by:
Eng-Choon Leong & Hossam Abuel-Naga

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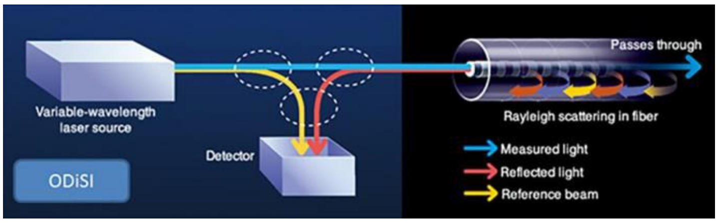

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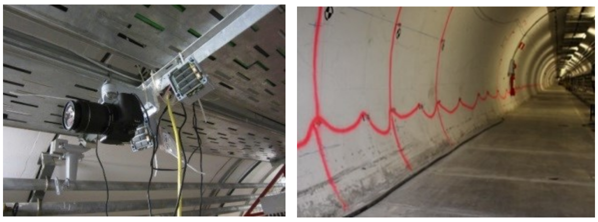

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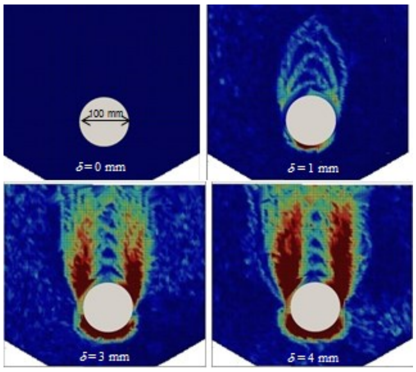

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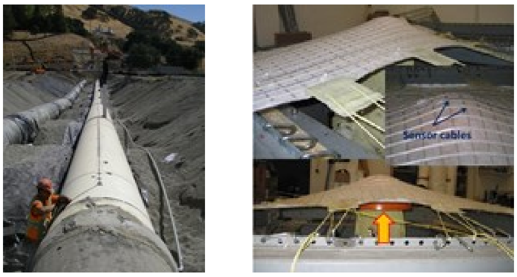

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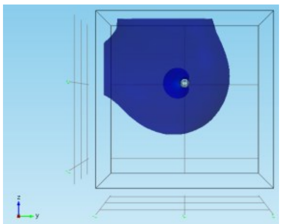

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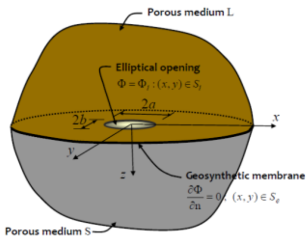

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Recent Advances in Geomaterial-Structure Interaction and Fiber-optic sensors

Dedicated to late Professor Alagiah Thurairajah

Guest Editor: Dr. Jey K. Jeyapalan, P.E.

Alagiah Thurairajah fondly called as Thurai was a dedicated teacher and researcher. He taught Soil Mechanics to a large number of students who are now spread all over the globe. A great mentor and educator Thurai is always remembered with much affection.

Thurairajah was born on 10 November 1934 in Kamparmalai in northern Ceylon. He was the son of Velupillai Alagiah and Sellammah from Imaiyanan in Vadamarachchi He was educated at the Udupiddy American Mission College and Hartley College. After completing school, he joined the University of Ceylon in July 1953, graduating with BSc degree in civil engineering in 1957. He then went to the University of Cambridge on a scholarship after Kenneth H. Roscoe chose him to be his research student. Between October 1958 and December 1961 Thurairajah assisted Roscoe in his research into shear properties of soils. This research earned Thurairajah a PhD in June 1962 with a thesis titled “Some shear properties of kaolin and of sand.”

Thurairajah married Rajeswari. They raised three daughters and two sons.

After Cambridge Thurairajah worked in London for a company named Terreasearch Ltd in 1962 before returning to the University of Ceylon as a lecturer. He was a visiting assistant professor at the University of Waterloo before becoming a Professor of Civil Engineering in 1971 at the University of Ceylon. He was the Dean of the Faculty of Engineering at the Peradeniya Campus of the University of Sri Lanka from May 1975 to September 1977, and February 1982 to February 1985. He was a visiting professor at the University of British Columbia between October 1977 and December 1978. He was the Dean of the Faculty of Engineering at the Open University of Sri Lanka from April 1987 to August 1988.

Thurairajah became the vice-chancellor of the University of Jaffna in September 1988. He resigned in March 1994 due to medical reasons. Thurairajah moved to Colombo for treatment and re-joined the Open University. He died on 11 June 1994 in Colombo. He was posthumously awarded the Maamanithar (Great Man) honor.

Thurairajah was a fellow of the National Academy of Sciences (Sri Lanka) from 1977; Institution of Engineers (Sri Lanka) from 1979; and the Institution of Civil Engineers (UK) from May 1985. He was the president of the National Academy of Sciences (Sri Lanka) in 1986 and the president of the Institution of Engineers (Sri Lanka) between October 1989 to October 1990. He was an expert in geotechnical engineering.

June 2019: Guest Editor Dr Jey Jeyapalan

Dr. Jeyapalan graduated from the University of Sri Lanka with first class honors in Civil Engineering; from Monash University with a master's degree in Applied Mathematics; and from the University of California at Berkeley with masters and doctoral degrees in geotechnical engineering with minors in structural engineering and engineering mechanics. He also was an engineering professor in USA and Germany. He is a renowned global water, wastewater, desalination, oil and gas industry expert with over 40 years of experience in pipeline design, market positioning of new technologies, construction methods, trenchless technology, pipeline integrity assessment and rehabilitation, telecommunications, underground utilities and structures, hydropower penstocks and tunnels up to 14.6 m. in diameter, industry standards, codes and regulations, and sharing rights-of-way of existing pipelines to house optical fiber networks and other cables. Dr. Jeyapalan developed the techniques for evaluating the potential of flow failures and for preparing inundation maps for mine tailings impoundments in 1979 and these tools are still the state-of-the- art used by mining companies and regulatory agencies for selection of suitable sites for mine tailings disposal around the globe. Dr. Jeyapalan has worked as an expert witness on numerous lawsuits and claims for failures of pipelines made of clay, concrete, steel, ductile iron, plastics, and composites and underground cables. Dr. Jeyapalan has completed over 400 projects in Algeria, Australia, Austria, Canada, Chile, China, Egypt, Finland, Germany, Iceland, India, Italy, Japan, Korea, the Netherlands, Oman, Pakistan, the Philippines, Saudi Arabia, Singapore, Spain, Sweden, Switzerland, the United Arab Emirates, the United Kingdom, and the United States. Dr. Jeyapalan's writings on pipelines, cables, sharing rights of way, and underground structures are used widely in engineering practice. He is the author of the 400+ page authoritative book "Advances in Underground Pipeline Design, Construction and Management," where he has shared his practical lessons with readers. He chaired the Executive Committee of the Pipeline Division of the American Society of Civil Engineers (ASCE) and the 1^{st} and 2^{nd} International Conferences on Advances in Underground Pipeline Engineering sponsored by the ASCE. Dr. Jeyapalan was the founding chair of the ASTM International Committee F-36, writing global standards on the last mile technologies, FTTX, underground utilities, cables, asset management, etc. He served on numerous other pipe and cable related standard writing bodies, technical committees and working groups within ASTM, AWWA, ASCE, Cigre', and IEEE. He is the author of over 200 papers and has taught over 100 seminars on underground pipelines and cables to engineers and contractors worldwide and is a registered professional engineer.

GEOTECHNICAL ENGINEERING

Preface

There are 18 peer reviewed papers reporting on the recent advances in geomaterial-structure interaction and fiber-optic sensors forming this volume 50 Issue No. 2. The authors and the peer reviewers are to be commended for their devotion to their field of expertise and their initiatives to share their knowledge with others/.

The first paper is by V. Di Murro, L. Pelecanos, K. Soga, C. Kechavarzi, R.F. Morton, and L. Scibile on Long-term deformation monitoring of CERN concrete-lined tunnels using distributed fibre-optic sensing: The Centre for European Nuclear Research (CERN) uses large and complex scientific instruments to study the basic constituents of matter by operating a network of underground particle accelerators and appurtenant tunnels. Long-term safety and structural health of this critical infrastructure highlighted the need for a sensing plan that could provide remote monitoring and resistance to high radiation. A pilot Distributed Fibre Optic Sensing (DFOS) system using Brillouin scattering was used to instrument 8 tunnel sections and obtain short-term readings.

The second paper is by N. Noether and S. von der Mark on Distributed Brillouin Sensing for Geotechnical Infrastructure: Capabilities and Challenges: Distributed Brillouin sensing has become a state-of-the-art tool for strain and temperature monitoring in concrete and geotechnical applications throughout the civil construction industry. While commercially available systems are steadily advancing in terms of spatial resolution and measurement length, end-users in field installations often put the focus on softer parameters like linearity or optical budget when evaluating the performance of the technology. This paper addresses the implications of high spatial resolution to the accuracy of relative and absolute strain and temperature data from the perspective of the Brillouin optical frequency domain analysis (BOFDA) technology and outlines the need for a clear definition and a standardization scheme to make the terms dynamic range and optical budget comparable between different instruments and technologies. Data from field applications in concrete pile monitoring is used to discuss the above aspects.

The third paper by W. Lienhart is on State-of-the Art of geotechnical monitoring with geodetic techniques: Within the last decades geodetic deformation monitoring has evolved from manual measurements of a small number of marked points to fully automated, large scale and high precision automatic warning systems. This article reviews the state-of-the art and discusses the potential of current geodetic techniques. It is demonstrated that modern geodetic techniques are capable to perform long-term measurements with millimetre or even sub millimetre accuracy over long distances and completely remotely. This is crucial especially in geotechnical monitoring where the structure may not be accessible due to safety reasons. The applicability of methods like laser scanning, robotic total stations, image-based measurements and furthermore is demonstrated with case studies including the monitoring of landslides, retaining walls, pipelines and water dams.

In the paper (fourth) by P. Rajeev and D. Robert on Failure probability of buried corroded cast iron pipes subjected to operational loads: Cast iron (CI) pipes are among the oldest buried assets in many water supply networks. The increasing failure rate in deteriorating pipe and unplanned failures will increase economical loss and social impact. Therefore, asset management tools are required to foresee effectively the future failures and schedule repair and replacement cost. One of the important tasks in the asset management framework is to estimate the pipe stress of a certain pipe section subjected to operational loads and corrosion. These factors may, however, be considered uncertain not only at a given point of time, but also have substantial time variance. The probability of structural failure throughout the life of the pipe can be estimated using Monte Carlo simulation, the first-order reliability method (FORM) and the second-order reliability method (SORM) to account for these uncertainties. This paper assesses the pipe performance using different theoretical pipe stress prediction models and 3-D finite element analysis.

The fifth paper is on Comparative study of distributed sensors for strain monitoring of pipelines by B. Glisic Natural calamities such as landslides, sinkholes, and earthquakes, as well as man-induced events such as vandalism and terrorist acts, can cause significant deformation and damage to pipelines with potentially devastating humanitarian, social, economic, and ecologic consequences. Therefore, a real-time assessment of the condition of pipelines during and after such events is crucial. Distributed fibre optic technologies are ideal candidates for monitoring pipelines, due to their large spatial range, and relatively small spatial resolution. Nevertheless, practical manufacturing and implementation of distributed strain sensors, as well as their response to various actions is not yet fully understood. The aim of this paper is to compare performances of different distributed fibre optic strain sensors in terms of strain transfer quality, costs, and implementation approaches. Comparison is made qualitatively, based on experience, and quantitatively, through large-scale testing, by simultaneously exposing different sensors bonded on the pipeline wall and embedded in the soil in its proximity, to various levels of artificially induced permanent ground movement.

In the sixth paper on Laterally Loaded Pile Test Instrumented Using Distributed Fibre Optic Sensors by H. Mohamad, B.P. Tee, M.F. Chong, K.A. Ang, A.S.A. Rashid and R.A. Abdullah: Instrumented horizontal pile load test is widely used to evaluate lateral soil resistances/parameters and to verify design assumptions. Typical instrumentation required for lateral pile load test are displacement sensors, i.e. dial gauge, to measure pile top deflection and inclinometer to measure lateral pile load-deflection profile. Recent technological advancement of optical fibre sensing has led new ways in measuring the lateral load-deflection profile. The distributed sensing, namely Brillouin Optical Time Domain Analysis (BOTDA) is a novel technique of measuring strains in a continuous manner. By installing distributed fibre optic strain sensing cables, continuous strain profile throughout the pile can be obtained. With the continuous strain profile, lateral load-deflection profile of the pile can be plotted by integrating the strain profile. Any anomalies, i.e., crack in test pile can also be detected directly from the continuous strain profile. The objective of this article is to present one of the earliest deployment of BOTDA optical fibre sensors in lateral pile load test in Malaysia under offshore environment and share invaluable lessons learned from the instrumentation process. Installation method, lateral load test setup and data interpretation are also discussed. Computed lateral pile load-deflection profile was in excellent agreement with measured pile top deflection using displacement sensors. Location of crack detected based on continuous strain profile was also in good agreement with result of Low Strain Integrity Testing.

The seventh paper by C. Kechavarzi, L. Pelecanos, N. de Battista and K. Soga is on Distributed fibre optic sensing for monitoring reinforced concrete piles: The spatially continuous strain data from DFOS provide detailed information about load transfer along the pile but can also be used to calculate vertical displacements and shaft friction through numerical integration and differentiation, which are useful for validating relevant performance-based numerical models. This paper introduces the methodology and illustrates these advantages through an example obtained from an instrumented pile load test in London. While it synthesises, several lessons learned in the application of DFOS for pile testing, it also supports the case for routine long-term monitoring of working piles.

The subsequent paper eight in the series is by Indrasenan Thusyanthan and Dilan Robert. This paper presents state-of-the-art knowledge on upheaval buckling, providing an overview on commonly used upheaval buckling soil models, latest uplift resistance results from experimental and numerical studies, investigations into the factors affecting the uplift resistance of soils and recommendations for design. The paper addresses the uplift resistance for both onshore and offshore pipelines. For onshore pipelines, the backfill soil cover could be dry, fully saturated or partially saturated. Thus, insight into the effects of degree of soil saturation on the uplift resistance is provided. For offshore pipelines, predicting the uplift resistance of buried pipelines has been a challenge due to uncertainty and randomness of the soil cover created by various pipe burial techniques. This paper provides guidelines, supported by published literature, on the uplift resistance of different types of backfills such as sands, clays and blocky clays. An insight into the cyclic ratcheting mechanism, which is the driving mechanism leading to UHB pipeline failures, is also provided. It is expected that the paper will be a valuable source of information for designers and consultants undertaking pipeline designs both onshore and offshore.

Indrasenan Thusyanthan is the author of the ninth paper on Cost Effective Free Span Rectification for Offshore Pipelines: Offshore pipelines often experience free spans due to uneven seabed, local scour or a storm event. When free span lengths are beyond acceptable limits, vortex induced vibrations (VIV) can cause pipelines to undergo fatigue damage and severely reduce the pipeline's design life. Therefore, surface laid offshore pipelines are periodically surveyed to ensure that there are no free spans that are beyond the acceptable limit. When such free spans are identified, they are rectified immediately, often by grout bags; however, it does not always provide a long-term remedy to free spans. Often lines rectified by grout bags needs further free span rectification the following year. This paper presents a cost effective long-term free span rectification method known as "Pipeline Lowering." This paper provides new knowledge for pipeline engineers, contractors and operators who need to ensure free spans are rectified safely and efficiently.

The tenth paper is by D. Inaudi on Distributed Optical Fibre Sensors for Strain and Deformation Monitoring of Pipelines and Penstocks: Pipeline and penstock management present challenges that are quite unique. Their long length, high value, high risk and often difficult access conditions require continuous monitoring and optimizing maintenance interventions. One of the main concerns for pipeline owners involves the development of excessive strain due to external action, potentially leading to cracking or buckling. The onset of those strain hot-spots can be detected and localized using distributed fiber-optic sensors. Additionally, pipeline strain distribution and soil movement can be identified using the same technology. The aim of this review paper is to present the main technologies used for distributed strain and deformation monitoring of pipelines or penstocks and illustrate their applications through several application examples.

Ravin N Deo, Chunshun Zhang, Jian Ji, Suranji Rathnayaka, Benjamin Shannon, Jayantha K Kodikara are the authors of the eleventh paper on A methodology for identification of pipe failure hotspots: This study provides a methodology that can be utilised for identifying pipe sections, which can be considered under high risk of failure. Application of the proposed methodology is demonstrated using a case study involving an in-service large (~1.7 km) critical water main in Sydney, Australia. Geospatial features from Google Earth ProTM and Google Street ViewTM were used to assess and quantify typical urban environmental attributes, which can be used for identifying pipe failure hotspot locations. Failure history was used to verify the basis of the methodology developed. It was demonstrated that a sound assessment of the pipe conditions is possible through inexpensive geospatial feature analysis. This development can greatly enhance and reduce costs associated with current pipe condition assessment processes.

12th in the series is the paper, ADYTrack: Development of a Railroad Trackbed Model, Validation and Parametric Study of Track Modulus, by Asif Arshid, Ying Huang, and Denver Tolliver: Deformation prediction of railroad trackbed has always been a challenge for the railroad designers and engineers. There are many complex interactions that take place simultaneously between the superstructure and the subgrade of railways trackbed, which simply make the deformation predictions harder. Numerical models offer an alternative to simulate the performance of the substructure of railroad with considerable accuracy. In this paper, a finite element based three-dimensional (3D) model has been developed in MATLAB. This model has the capability to study the effects of track modulus, subgrade modulus, interactions between track and soil, the track geometry, and the wheel loads. The results of the ADYTrack are validated with other numerical models and full-scale field test results reported in the literature.

The 13th paper by Klar, A., Linker, R., and Herrmann, S., on Leakage-induced pipeline stressing and its potential detection by distributed fiber optic sensing: The paper aims to develop an approximated analytical solution to model the bending moment profile in a sewage pipe, buried within an unsaturated soil, which occurs because of a leak. The solution involves evaluation of the greenfield displacements due to a buried point source, and its use as an input to a soil-pipeline interaction problem. The solution is extended for a general wetted sphere (having different degree of saturation with the radial distance). The final model is tested against finite element simulations of the coupled problem without the simplified assumptions and approximations and is found to be satisfactory. The work may be considered a first step towards realization of a distributed fiber optic sensing system that, together with an appropriate spatial signal analysis, could identify leaks at their early stage. The current analysis indicates that the developed strain signal (and its profile) could be detectable for leaks having liquid loss as little as 300 to 500 liters.

A. Wosniok and K. Krebber are the authors of the 14th paper on Smart Geosynthetics based on Distributed Fiber-optic Sensors in Geotechnical Engineering: Smart geosynthetics with embedded optical fibers as distributed sensors provide solutions both for applications in geotechnical engineering and for cost-effective monitoring of critical infrastructures. The incorporation of glass or polymer optical fibers (GOFs or POFs) in geotextiles and geogrids allows early detection of mechanical deformations, temperature and humidity. This paper presents selected examples of smart geosynthetics based on Brillouin and Rayleigh scattering effects in incorporated fiber optic sensors for monitoring of large geotechnical structures like dikes, dams, railways, embankments or slopes. The focus of the presented work is on real field tests of measurement capability with respect to the chosen measurement principle and used fiber type.

The fifteenth paper is by A. P.S. Selvadurai on Mechanics of geosynthetics subjected to chemical exposure: Experiments, constitutive models and computations: The paper presents results of recent research related to the development of advanced mathematical models for describing the behavior of strain rate sensitive materials such as geosynthetics that are used extensively as barriers to the migration of contaminants and other hazardous materials. The important finding of the research is that the leaching of the plasticizer from the geosynthetic can lead to a loss of hyperelasticity of the material, which is a key functional requirement for a geosynthetic. It is also shown that constitutive models can be developed to describe the mechanical behavior of the geosynthetic in its virgin state and upon direct exposure to pure ethanol for thirteen months. A computational approach is used to evaluate the results of separate laboratory experiments involving transverse indentation of geosynthetic membranes that are fixed along a circular boundary and tested in either its untreated state or after prolonged exposure to ethanol.

C. Prohasky, R. Vivekanantham, P. Rajeev, H. Bao, and S. Roy are the authors of the 16th paper on Monitoring of buried pipeline using distributed fibre optic technologies: Combined acoustic-temperature-strain sensing: Infrastructure monitoring, such as pipeline monitoring, is becoming crucial to achieve improved asset management for more sustainable future. This paper presents the development of distributed optical fiber sensing system, which combined acoustic-temperature-strain sensing to enhance the condition monitoring of buried pipeline. The performance of developed optical fiber system was tested using the 140 m long pipe-soil test facility built in the Hawk testing yard. Cement lined steel pipes with the diameter of 100 mm and 500 mm were buried at the depth of 800 mm and optical fiber cables were attached at four different locations around the pipe section. The pipe section was also instrumented with contact microphones to detect the acoustic signal, which was then used to validate the optical fiber measurements. Various size of leaks was made along the pipe section and monitored using the acoustic signal and temperature sensing. Both acoustic and temperature sensing detected the leak reliably with required accuracy up to distance of 40 km. The system can detect the leak down to 2 mm with the resolution of 0.5 m. Using the combination of acoustic and temperature helped confirm the leak and reduce the false positives. The strain sensing also provided reliable results for pipe bending test with the resolution of 20 uε. The advantage of having the combined monitoring of strain helped to evaluate the stress increment in pipe section due to leak induced soil erosion.

The 17th paper on Benefits of standardization of FOS in soil-structure interaction applications is by H. R. Habel and J.K. Jeyapalan: Measurement and data recording systems are important parts of a holistic Soil-Structure Interaction Health Monitoring (SSIHM) system. New sensor technologies such as fiber-optic sensors (FOS) are regarded at times as experimental despite the strong track record; standards or at least guidelines not being widely available internationally has always been an impediment. This lack in standardization makes the acceptance of FOS technologies in SSIHM systems more difficult. Some success has been made in publishing first standards to fill this gap over the past decade. Much more effort is needed in this area and this paper gives an overview of what has been accomplished, what is in progress, and what obstacles were along the way. A case is made for a truly independent standard writing platform that can govern itself for the fiber-optic sensing industry composed of its sellers, buyers and subject matter experts.

The last paper of this issue is the 18th paper on Rational Methods of Steel Pipe Design Accounting for Poor Native Soils and Soil Migration by J. K. Jeyapalan, G. Leonhardt, P. Rajeev, and A. M. Britto: In poor native soils there is always a concern whether sufficient embedment support around the haunch and spring line level exists to prevent over-deflection of steel pipe. Engineers become confused given the two extreme positions on trench width – steel pipe suppliers advocating two pipe diameters while the U.S. Bureau of Reclamation recommending the use of five pipe diameters. Methods from the German ATV A127 or Leonhardt, rely on a ratio of the side fill En' to the embedment Eb' and the ratio of the trench width to the pipe size to select the trench width. When pipe suppliers quote Marston's work on rigid concrete pipe from 1913, to make their case that a relatively narrow trench is better in poor native soils even for flexible steel pipe, they introduce the risk of inducing the buyers to ask - has the pipeline industry not seen new developments over the past 100 plus years? This paper reviews the fallacies surrounding methods on how to cope with poor trench wall conditions and provides a rational method. This paper covers soil migration, and the adverse consequences if not considered.

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ACKNOWLEDGEMENTS

Eighteen papers are contained in this issue. The Guest Editor is Dr Jey Jeyapalan . No doubt the material contained herein would be most valuable to our profession. The editors have adequately described the contributions in the preface. They are to be congratulated for these contributions.

Dr. Teik Aun Ooi
Prof. San Shyan Lin
Prof. Kwet Yew Yong
Dr. Noppadol Phienwej
Prof. A. S. Balasubramaniam

GEOTECHNICAL ENGINEERING

June 2019 Issue on Recent Advances in Pipelines, Soil-Structure Interaction and Fiber-Optic Sensors

Edited by: Dr Jey Jeyapalan

List of Papers **Page**

GEOTECHNICAL ENGINEERING

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SEAGS Southeast Asian Geotechnical Society

AGSSEA Association of Geotechnical Societies in Southeast Asia

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AIT Asian Institute of Technology

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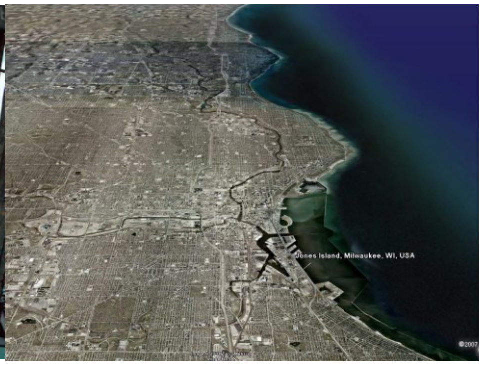
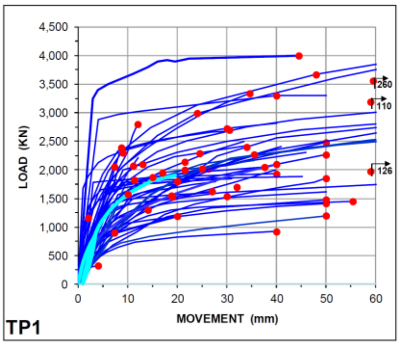
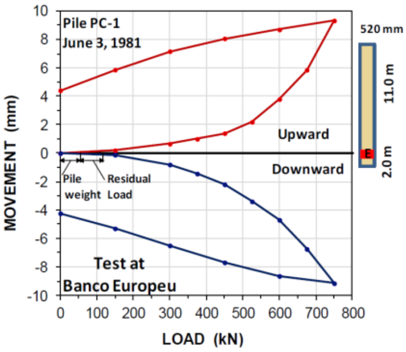
Honouring Dr Bengt Fellenius: Guest Editor: Dr.Phung Duc Long

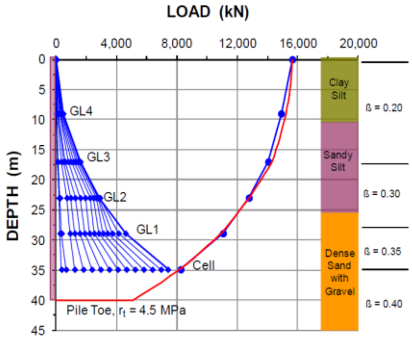


Sven Hansbo Lecture Hanoi 2016 G Lorenz, DBM Contractors Milwaukee project: Fellenius et al, 1989

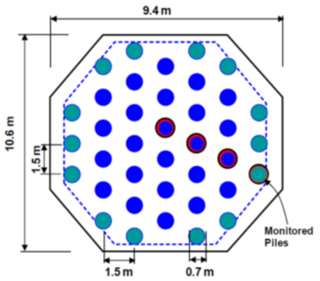
O-Cell Testing : Manila, Philippines **Planing Intergrity Testing** **The Bäckebol site in June 1968: Downdrag**

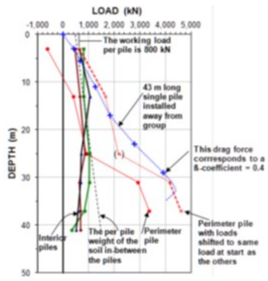


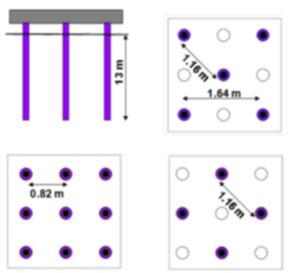


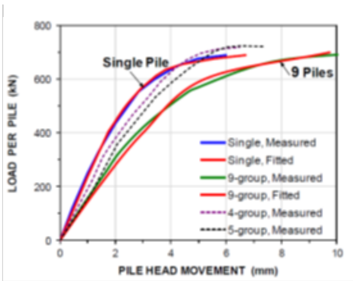


Response to load: Four different bored piles **Response to Bi-directional Test** **Load distributions**









Pile Groups, Okabe:1977 **Load Distribution in piles** **Pile Groups: Okabe, 1977** **Pile head Movements**

Honouring Dr Bengt Fellenius

Dr. Bengt H. Fellenius is a professional engineer specializing in foundation design and studies by participation in project teams, special investigations, instrumented field tests, etc. Services are also provided in regard to construction problems, claims, and litigation in collaboration with Consultants and Contractors, as well as Owners. Dr. Fellenius, Professor of Civil Engineering at the University of Ottawa from 1979 through 1998, is an internationally recognized authority in the field of soil mechanics and foundation engineering, and, in particular, in deep foundations. He has gained a wealth of practical experience during more than 50 years of work at home and overseas through a variety of assignments that encompass foundation, embankment, and soil improvement design for water and sewage treatment plants, industrial plants, as well as bridges, highway, and airport projects, and marine structures and urban area development projects; some of which he has written up in 300+ technical journal and conference papers, articles, books, and book chapters. Copies of many of the papers are available for downloading from Dr. Fellenius' web site: [www.Fellenius.net]

Dr. Fellenius moved from his native Sweden to Canada in 1972 where he worked on foundation investigations and design and construction projects in North America and overseas. In 1973, he was one of the first to apply geotextile soil separation sheets to stabilize roadbeds and construction surfaces, investigating conventional carpet underlay (Celanese) for this purpose. He was active in promoting to the US market the splicing of prestressed concrete piles by means of mechanical full-strength splices, and he introduced to Canada and the USA ground improvement applications of lime column method for reducing soil compressibility and wick drains (the Geodrain and Alidrain) for accelerating consolidation and stabilizing landslides. He was one of the earliest (1977) to research and use dynamic testing and the Pile Driving Analyzer in actual project design and construction.

In 1984 he introduced the Janbu method of determining soil compressibility and analysis of settlement. He has also had a fundamental part of the development of commercial software for analysis of settlement from loads on natural soils and soils subjected to soil improvement methods, design of piled foundations, and other software. In 1984, he published the design and analysis method for foundation design known as the "Unified Method of Design for Capacity, Drag Force, Settlement, and Downdrag".

Dr. Fellenius is and has been an active participant in many national and international professional societies and research associations and in Canadian and US Codes and Standards Development. For example, Member of the subcommittee for the American Society for Testing and Materials D-4945 Standard for High-Strain Dynamic Testing of Piles; Chairman of the Canadian Geotechnical Society, CGS, Technical Committee on Foundations writing the 1985 Canadian Foundation Engineering Manual; Member of the Ministry of Transportation Committee for the Development of the 1983 and 1992 Ontario Bridge Design Code; Author of three Public Works Canada publications: Marine Division Master Specifications for Piling, Pile Design Guidelines, and Hammer Selection Guide; Past Overseas Correspondent Member to the Geotechnical Engineering Advisory Panel of the Institution of Civil Engineers, ICE (London); and Past Member of Editorial Board for the ASCE Geotechnical Engineering Journal.

Dr. Fellenius has given lectures and courses to several universities and been invited lecturer at international conferences throughout Europe, the Americas, and South-east Asia.

Guest Editor: Dr. Phung Duc Long

Dr. Phung is President of the Vietnamese Society for Soil Mechanics and Geotechnical Engineering (VSSMGE). He received his Ph.D. degree at the Geotechnical Department, Chalmers University of Technology in Gothenburg, Sweden in 1993. He has worked at the Institute for Building Science & Technology (IBST) in Hanoi, Vietnam from 1975 to 1988; at the Swedish Geotechnical Institute (SGI) in Linköping, Sweden from 1988 to 1994; at Chalmers University of Technology from 1989 to 1993, at Skanska Sweden as Technical Manager from 1994 to 2002; at WSP Asia in Hong Kong as Associate Director from 2002-2003; at WSP Vietnam in Hanoi as General Director from 2003-2011; and at Long GeoDesign as Director since 2011.

Dr. Phung has 40 years of international experience. His expertise areas are: deep foundations and piled raft foundations for high-rise buildings, temporary and permanent support for deep excavations, tunneling, soil improvement, underpinning, pile dynamics, and numerical analysis of soil-structure interaction problems. He has worked with projects in many countries, as Sweden, Norway, Denmark, USA, England, Russia, Germany, India, Hong Kong, China and Vietnam, etc. Some of his highlight projects are: Uni-Storebrand Headquarter in Oslo with steel-core piles into rock; SL-10 South Link in Stockholm with sheet pile wall for deep cut & cover tunnel in soft clay; Fredriksberg Metro Station in Copenhagen, the world largest drilled-pile wall for deep excavation; soil stabilization with lime-cement columns for Highway I15, Salt Lake City, Utah, USA; Öresund Link between Sweden and Denmark; Årsta Bridge in Stockholm with pile foundations and sheet pile walls in deep water and soft clay; the peer-review of piled foundation for the ICC Tower, 118 floors, 490m high in Hong Kong, the No. 4 tallest high-rise in the world, and the Sailing Tower in Ho Chi Minh City, Vietnam. He is the author and co-author of more than 100 technical papers and books in English, Swedish and Vietnamese for different national, regional and international seminars, conferences, and technical journals. He is the chief editor of a number of publications, as the proceeding of the international conferences Geotec Hanoi 2011, and Geotec Hanoi 2013.

Target Dates: Topic & Contributing Authors

1: Target Date for First Submission of Manuscripts:
September 2018

2: Review and corrections of manuscripts: June to December 2018

3: Target Date of Release: September 2019

Preface

There are eighteen peer reviewed papers in this Issue of the journal honoring Dr Bengt Fellenius. The guest editor is Dr Phung Duc Long.

The first paper is K. R. Massasch and C. Wersäll Monitoring and Process Control of Vibratory Driving: Vibrators are used increasingly in the foundation industry, primarily for installation of piles and sheet piles, but also for deep vibratory compaction. Fundamentals of vibratory driving are described, which make it possible to choose vibrator performance parameters based on field monitoring and performance control. Variable frequency and amplitude vibrators have become available which make it possible to adapt the driving process to project-specific requirements. The components of modern electronic measuring systems are described, which can be used to monitor, control and document different aspects of vibratory driving. Two examples are presented - vibratory driving of sheet piles and resonance compaction – which show how the performance of vibrators and sheet piles can be analyzed and adapted to meet specific requirements. Using the advanced monitoring and process control systems, the efficiency of vibratory driving could be enhanced. From the retrieved parameters, a better understanding of the vibratory driving process is gained, which can be used to develop a valuable database.

The second paper on Enhanced Ultrasonic Testing of Drilled Shafts and Barrettes is by Joram M Amir: Ultrasonic cross hole testing can provides a detailed and accurate mapping of concrete quality inside the drilled shaft. However, it is unable to reliably map the perimeter of the shaft beyond the reinforcement cage. Unfortunately, this is the zone where most flaws occur. Using innovative technology the method presented, proven in field tests, overcomes this shortcoming.

In the third paper is titled Load-movement response by t-z and q-z functions by Mohammad Manzur Rahman and Bengt H. Fellenius: A static loading test provides more than a "capacity", its primary use is to show the load-movement response of the pile-and-soil system in order to assist in analysis of the transfer of a supported load to the soil. A pile is an axial unit composed of a series of short lengths (elements) that are affected by shaft shear or toe stress, expressed as a relation of stress (load) versus movement for the element. The analysis of the load-transfer must consider the development of shaft shear and toe resistances as a function of movement for a pile shaft or toe element, as expressed in a load-transfer function commonly called t-z and q-z function. The conditions of the soil around a pile determine the response of the elements making up a pile. As soil layering usually differs along a pile, the t-z function best modelling the response of an element differs along a pile. The response of a pile head, that is, the actual pile load-movement curve, is the sum of the response of the individual pile elements. Fitting the theoretical load-movement response to actual test results by trial-and-error applying a series of shaft (t-z) functions and a toe (q-z) function, enables a calibration of a site that serves to establish the load-transfer conditions of a piled foundation at the site needed for determining what short and long-term settlement the foundation will experience. Something a crude "capacity" assessment will not do. Eight functions for modelling strain-hardening and strain-softening response are presented in the paper and their use in fitting theoretical to actual results is illustrated.

The fourth paper on Common mistakes in static loading test procedure and result analysis is by Bengt H. Fellenius And Ba N. Nguyen: Since long, routine static loading tests on piles are arranged in many different ways ranging from quick tests to slow test, from constant-rate-of-penetration to maintained load, from straight loading to cyclic loading, to mention a few basic differences. Frequently, size of load increments and of load-holding times varies and the procedure incorporates unloading-reloading events ("cycles"). The tremendous development of instrumentation over the past decades has enabled also routine tests to be supplemented with instrumentation for measuring strain along the test pile. The instrumentation enables the load-induced axial strains in the pile to be accurately measured. The strains are converted to load by multiplication with the pile axial stiffness, EA. Both the modulus, E, and the pile area, A, are often uncertain values. Unless the pile material is steel, the E for a concrete pile can range from a value as low as 20 through a high of 50 GPa, though, usually from 25 through 35 GPa, and its actual values is strain and stress dependent. In a bored pile, the actual pile size can differ from the nominal by 50 % or more, usually, the actual size is larger than the nominal. However, if the analysis is directed to determining and applying the pile stiffness directly, the uncertainty and inaccuracy can offset provided that proper test procedure is stringently adhered to. A couple of case histories are presented to show that proper procedure involves keeping all load increments equal, all load-holding times the same, always using strain-gages in pairs, and avoiding all unloading and reloading events.

Julian Seidel in the fifth paper deals with the Evaluation of the capacity of untested driven piles: Driven piles continue to be an attractive foundation solution in particular geologies and a necessary foundation solution for most projects over water. Piles are typically installed to provide support for axial compression loads, although the tensile and lateral capacities they provide may be critical for design in some instances. The capacity of individual piles has traditionally been tested by static loading and by dynamic pile testing methods since the early 1980s. These dynamic methods rely on measurement and interpretation of the pile stress waves initiated by the piling hammer and reflected by the surrounding soil. The reliability of static and dynamic test methods has been the subject of numerous studies and papers. Due to cost and delay considerations, generally less than 1% of piles are tested statically and less than 10% of piles are tested dynamically. This means that between 90% and 99% of piles are not tested, but their capacity is inferred by other means. As untested piles are as critical in providing structure support as tested piles, the need to reliably estimate the capacity of these untested piles is clear. These methods of assessment must be simple and must be capable of providing real-time confirmation of capacity at the time of driving.

There is a long history of evaluation of the capacity of untested driven piles based on equating the energy of the piling hammer with the work done by the pile against the resistance of the surrounding soil and rock. There are many variants of this general approach, which are generally referred to as “pile driving formulas”. The Engineering News Formula, the Janbu Formula and the Hiley Formula are three of the better known of many published formulas. The technical literature especially that predating the advent of dynamic pile testing is littered with comparisons of various pile driving formulas and static load testing. No formula is found to provide a standalone reliable basis for pile capacity estimation, and hence such formulas are typically used with large factors of safety. There are many reasons which contribute to these poor predictions, including limitations of the formulas, time-dependent pile capacity changes, and the variability of hammer performance, which is significant but not generally recognized.

The development of Wave Equation Analysis in 1960 provided an improved framework for modelling the pile-driving process, and for predicting the relationship between pile capacity and blow count for an assumed set of static and dynamic soil parameters, and driving system characteristics. The result is a so-called Bearing Graph, which is unique for the particular set of parameters, most significantly including the hammer energy. Different assumptions of hammer stroke or efficiency will result in a suite of sub-parallel curves, each corresponding to a particular energy transfer to the pile.

Calculation of energy transferred to the pile is only possible for those piles which are dynamically tested and for which pile-top strain and velocity are measured. For untested piles, the energy delivered to each pile is not known, a constant hammer efficiency is generally (but incorrectly) assumed in practice.

This paper describes an alternative approach to pile capacity estimation based on Wave Equation Analysis and real-time monitoring of pile set and peak pile velocity. In this new approach, the traditional Bearing Graph, which is an expression of the relationship between pile capacity and blow count, is normalized by the capacity at a reference blow count, normally effective refusal. This normalized Bearing Graph or Relative Capacity Graph is a representation of the pile capacity at any blow count, relative to the capacity at effective refusal. Although not unique, the Relative Capacity Graph varies over a small range for the majority of piling conditions, and importantly is independent of hammer energy.

The pile capacity which can be mobilized by a hammer impact not only depends on the energy imparted, but also on the maximum applied force. At effective refusal, the capacity is typically equal to the peak force with a ±10% range. The specific Refusal Capacity-Force ratio for any piling project can be estimated in advance by Wave Equation analysis, and confirmed by Wave Matching of dynamic pile testing. Peak pile force can be calculated from the peak pile velocity and the pile impedance, Z. Once the Refusal Capacity-Force Ratio and the Relative Capacity Graph are established for a project, the capacity of untested piles can be determined independent of hammer energy by measurement of pile set and peak pile velocity. The paper will detail this alternative pile capacity estimation approach, demonstrate its application to some historical data, and compare its reliability to the range of alternative energy-based methods currently in use.

Experimental investigations and analysis of piles under combined thermo-mechanical loading is the title of the sixth paper by G. Russo and G. Marone : The use of pile foundations as heat exchangers in combination with heat pump are becoming increasingly popular. This occurs for a number of reasons mainly related to the developments of more efficient and environmental friendly solutions for the building conditioning. A number of field experiments and small-scale tests are available to get an insight in the mechanism governing pile-soil interaction under thermo-mechanical loading. On the other hand, numerical analysis represents a powerful tool to simulate thermo-mechanical coupling. In the paper both experimental investigations and numerical FEM simulations are used to define the interaction between the stresses and the strains field induced by thermal loadings and by axial loading in single free head pile. The paper focus is on the overall load-settlement behaviour of piles under combined mechanical and thermal loading.

The seventh paper is titled A METHOD TO ESTIMATE SHAFT AND BASE RESPONSES OF Using PILE LOAD TESTS and is by Madhav Madhira and Kota Vijay Kiran: In practice, the ultimate capacity of the pile foundation is estimated considering strengths and unit weights of soil layers with depth, overburden pressure and other parameters. The estimated capacities need always to be validated by conducting initial vertical maintained load test. The estimated capacity may differ with actual one as values of strength, stiffness, interface resistance between pile and soil and lateral earth pressure coefficient with depth and soil stratification could be different from the values estimated from prior testing or assumed. The estimation of axial capacity of piles involves considerable uncertainties in selection of appropriate design parameters and design rules are not always consistent with the installation procedures/processes involved.

Due the aforementioned discrepancies of usual practice, a new approach to back-analyze and estimate ultimate base and shaft resistances, initial stiffnesses of shaft and base of pile respectively based on load - displacement response from pile load test is presented. The topic is momentous as current design methods often largely underestimate the capacity of piles, resulting in an over-conservative design. Also, the new approach can permit verification of the a-priori predictions based on geotechnical parameters, geometry (shape, length and diameter), construction methodology and other uncertainties involved at site during installation of the pile.

The proposed approach is based on an iterative procedure by deploying hyperbolic relationships for the non-linear responses of shaft and base resistances, and estimating initial shaft and base stiffnesses and ultimate shaft and base resistances of a pile from pile load test results. The pile-soil system is modelled in terms of Winkler model with different non-linear responses for the shaft-soil and base resistances. Iterative analysis is then used to arrive at the shaft-soil and base stiffnesses and the ultimate shaft and base resistances.The load - settlement response curve for working load is constructed by combining shaft and base load responses with settlement. This approach is both simple and easy to apply. The capability of the procedure to predict shaft and base stiffnesses and ultimate shaft and base resistances is checked against data from full-scale axial load test on instrumented pile/s for efficacy.
The proposed approach is based on an iterative procedure by deploying hyperbolic relationships for the non-linear responses of shaft and base resistances, and estimating initial shaft and base stiffnesses and ultimate shaft and base resistances of a pile from pile load test results. The pile-soil system is modelled in terms of Winkler model with different non-linear responses for the shaft-soil and base resistances. Iterative analysis is then used to arrive at the shaft-soil and base stiffnesses and the ultimate shaft and base resistances. The load - settlement response curve for working load is constructed by combining shaft and base load responses with settlement. This approach is both simple and easy to apply. The capability of the procedure to predict shaft and base stiffnesses and ultimate shaft and base resistances is checked against data from full-scale axial load test on instrumented pile/s for efficacy.

The eighth paper is on STIFFENING EFFECT ON END BEARING GRANULAR PILES
M. R. Madhav, A. Vaibhaw Garg, and B. Jitendra Kumar Sharma: Ground improvement techniques are constantly drawing the attraction of geotechnical engineers due to the fact that the mechanical properties of

the soil are not adequate at some places. Among various economic options available for ground improvement is the use of granular piles (GP). Stone columns/granular piles composed of compacted gravel, sand or mixture of both are used. Stiffening of granular piles simply means that the material of the GP is replaced partially by some material, having better mechanical properties i.e. higher deformation modulus in comparison to conventional material of granular pile e.g. geo-grid encased columns, SDCM (stiffened deep cement mixing) etc. Partial stiffening means replacement of material in the top region of pile. Analyses of a single and group of two partially stiffened end bearing GPs is carried out in the present paper. Results in terms of top settlement influence, settlement interaction, and settlement reduction factors, percentage load transferred to the base, normalized shear stress distribution along the length of the pile are presented. Decreases in the top settlement influence factor with the increase in the relative stiffness factor as also the relative length of stiffening of the partially stiffened pile decrease as anticipated for both single as well as two pile group. In contrast the percentage load transferred to the base of the pile increases with the increase of the relative stiffness and relative length of stiffening of GP.

The ninth paper is on SIMPLIFIED DESIGN PROCEDURES FOR RECTANGULAR BARRETTE FOUNDATIONS by H. Chow, H.G. Poulos and J.C. Small: Rectangular barrette foundations are being used increasingly to support super-tall and mega-tall structures. For the design of such foundations, advanced numerical methods such as three-dimensional finite element analyses are being used increasingly and provide a valuable means of achieving a final design. However, for preliminary design, and for checking of the final design, simpler methods are invaluable. Unfortunately, most, if not all, of the available simpler methods involve pile and pile group analyses in which the piles are assumed to be circular. If such analyses are to be used for barrettes, then simplifications must be made so that an acceptable model of the barrette can be provided by means of a circular equivalent.
This paper examines various methods of simplification of a rectangular barrette by a circular pile, and assesses whether it is possible to obtain adequate accuracy with such simplifications. Both a single barrette and a group of 25 barrettes are considered, and the reference solutions are obtained via three-dimensional analyses using the commercial program PLAXIS3D. Both the ultimate limit state and the serviceability limit state are considered. For the simplified approach using circular piles, the program DEFPIG is used. From comparisons between these two approaches, recommendations are made for the simplified modelling of rectangular barrettes as single units and within a group.

Analysis of the behaviour of bored, continuous flight auger, root and full displacement piles, instrumented, performed in lateritic soil is the title of the tenth paper. The authors are: P.J.R. Albuquerque, J.R. Garcia and D. Carvalho : This paper presents and analyses the results of load tests performed on three bored piles, three CFA piles, three root piles and three full displacement piles, all 0.4 m in diameter and 12 m in length, performed in Experimental Site of Foundations and Soil Mechanics of Unicamp, Campinas, Brazil. The piles were instrumented in depth with strain-gages in order to obtain the transfer of load along the shaft. The subsoil is formed by diabasic; characterized as lateritic and unsaturated in the surface layer, classified as silty clay. The load tests were of the slow type (SMLT), following the prescriptions of the Brazilian Standard (ABNT NBR12.131). Based on the results and applying the Cambefort (1964) laws and Stiffness method proposed by Décourt (2008), it was possible to analyse the skin friction and tip load behaviour, as well as residual loads.

The paper titled Technical Issues on Load Test and Quality Test for Bored Pile and Diaphragm Wall is the eleventh in the series and by Takeshi. HOSO, Koji. WATANABE and Shinya MATSUSHITA: There are two kinds of tests for Bored Pile and Diaphragm Wall: “Load Tests” to confirm design parameters for bearing capacity such as Static Load Test and Dynamic Load Tests (High Strain Dynamic Test and Statnamic Load Test) and “Quality and Integrity Tests” to confirm quality of test pile such as Sonic Logging Test and Low Strain Load Test).For Load Tests, the following issues are discussed: Evaluation of test results focusing on concrete elastic modulus, Influence of slurry quality on mobilized skin friction, Influence of test pile shape on bearing capacity, Comparison between compressive load test and pile -toe load test and Reliability of dynamic load test. For Quality and Integrity Tests, interpretation of sonic logging test and low strain load test are described.

San-Shyan Lin, Tai-Hong Chen and Chia-Hong Lai in the 12th paper describe the *Interpretation* on Performance of Two Drilled Shafts Subjected to Tensile Loading: In this paper, conversion of measured strain data into pile loads for tensile load testing of two drilled shafts is studied using the secant modulus of concrete. A back analysis method, considering the possible effect of concrete cracking or slippage between steel-grout interfaces, is used in converting the strain into pile loads. Subsequently, the t-z curves along shaft are obtained based on the pile loads interpreted from back analysis.
The thirteenth paper is by K. Yamashita A. Uchida and T. Tanikawa on : Long-term behaviour of piled raft with grid-form deep mixing walls on reclaimed ground: This paper offers a case history of a piled raft foundation on reclaimed land, supporting a four-story parking garage measuring 213 m by 71 m. The subsoil consists of loose sand and very-soft to medium alluvial clay layers which are normally consolidated or underconsolidated, underlain by diluvial dense sandy layers. Since the thickness of the clay layers changes markedly near the centre of the site, 152 friction piles of different length (33-60 m in length) are used to reduce the consolidation settlement. In addition, as a countermeasure of liquefaction of the loose sand, grid-form cement deep mixing walls are employed. Field monitoring on the raft settlement and the load sharing between the piles and the raft was performed. The measured settlements about ten years after the end of the construction were roughly 20-100 mm. At the time of the 2011 off the Pacific coast of Tohoku Earthquake, no significant change in the raft settlement was observed while extensive soil liquefaction was observed in the reclaimed land. Consequently, the effectiveness of the piled raft system was confirmed.

Finite element modelling of a bidirectional pile test in Vietnam is the 14th paper: The authors are PHUNG Duc Long and William CHEANG: The prediction of the axial bearing capacity of piles is always a difficult task. Many design methods have been developed, and they can be used in the conceptual design. Static loading tests on single piles must be done for verification in the detailed design phase. These tests are very expensive and difficult to be carried out, especially for the large-diameter bored piles. The bidirectional test, or so-called Osterberg cell, is nowadays very common. The acceptance of numerical analyses in geotechnical problems is growing and the finite element method, FEM is more and more commonly applied in foundation design. FEM cannot replace the loading tests, yet could be a reliable tool for simulating loading tests on a single pile. In this paper, FEM is used for simulating a multi-level bidirectional test of a 2.5m-diameter, 80m long bored pile at the Cao Lanh cable-stayed bridge in the Mekong Delta, Vietnam. The FEM analysis using PLAXIS 2D is then compared with the monitored data.
The Cao Lanh cable-stayed bridge, a part of the Central Mekong Delta Connectivity project (CMDCP), crossing the Tien River is expected to be completed in 2017, Figure 1. The bridge has a main span length of 350m with 150m-side spans, and a maximum height above high water level of 35.7 m. The main bridge is supported by bored piles with a length varying between 85m and 115m, and a diameter of 2.5 m. Four testing piles, two at the pylons and two at the tie-down piers, were constructed prior to mass pilling work. In this paper, only Test pile P20 is discussed. Due to a high working load and the complicated site conditions, the conventional static and dynamic load test, which were commonly used in Vietnam, were impractical. The bi-directional test was therefore suggested.
Plaxis 2D is used for modelling the axi-symmetrical problem. In the analysis, the Hardening Soil (HS) was used to model the soil behaviour. For boundary value problems that involve a mixture of loading and unloading stress paths, such model is required as it captures all the general facets of soil behaviour. Soil is essentially a non-linear material for almost all operative stress and strain levels encountered in pile testing. Ideally the HS-small models should be used but, in this work, we will begin with HS model. The results obtained from the FEM analysis are compared with the loading test data only for Stage 1, i.e loading the lower cell to 12.4 MN and unloading to 0.0 MN. The comparison is shown in Fig. 10, and indicates generally a good agreement between the monitored and FEM results.

Finite Difference Analysis of Raft Foundations under Vertically Static Loads is the 15th paper by Der-Wen Chang and Hsin-Wei Lien: The Finite Difference Method (FDM) can be used to model two dimensional behaviours of the raft subjected to vertical loads using the classical Plate Theory (Bowles, 1977). Owing to the complexity of the boundary conditions, the complete solution of such method has never been presented. Instead of FDM analysis, finite grid method (FGM) simplifying the raft with fundamental structural elements has been established and discussed extensively. This paper presents the FD formulas following the thin-plate theory for raft foundation underlain by soil springs. Such solution is different from the FLAC analysis which was suggested on stress continuities derived at the material level. The discrete equations of the proposed analysis were derived assuming a surface foundation without the bending moments and shears at edges of the foundation. The solutions are then examined with the linearly elastic Finite Element solutions from three-dimensional Midas-GTS analysis for a model of surface raft foundation underlain by homogeneous and isotropic soils. The comparisons were made considering the variations of area ratio of the soil spring, soil stiffness, Poisson's ratio, effective length of soil springs, and thickness of the raft. The applicability and details of the solution are introduced. Figure 1 depicts the comparisons of the normalized settlements of the raft from the proposed analysis with those from Midas-GTS varying the area ratios of the soil springs for the nodes along the edges and at the corners with different lengths of the soil spring for the standard numerical model.

Bidirectional Loading Tests on Grouted and Not-Grouted Bored Piles in Vietnam is the title of the 16th paper by: Hai M. Nguyen, Anand J. Puppala, Long D. Phung and Trung T. Nguyen: The 40-storey apartment buildings of the Lancaster Lincoln project in Ho Chi Minh City, Vietnam was designed to be supported on a piled foundation consisting of bored piles each assigned a 21-MN working load. The foundation design included performing bidirectional-cell, static loading tests on three test piles. The soil profile consisted of organic soft clay to about 36 m depth followed by a thick deposit of sandy silt and silty sand with a density that gradually increased with depth from compact to dense, becoming very dense at 84 m depth. In September 2016, the test piles, one 1.8-m diameter pile and two 1.5-m diameter piles were installed to 68 through 85 m depth and constructed using reverse circulation drill technique with bentonite slurry and a casing advanced ahead of the hole. The bidirectional-cell assemblies were installed at 18 through 25 m above the pile toes. The piles were instrumented with pairs of diametrically opposed vibrating wire strain-gages at three through five levels below and seven through ten levels above the cell levels. After concreting, the shaft grouting was carried out along a 49-m length above the pile toe of one 1-5 m diameter pile. The static loading tests were performed about 28 days after the piles had been concreted. The analysis of strain-gage records indicated an average Young's modulus value of about 25 GPa for the nominal cross sections of the piles. The average unit grouted shaft resistances on the nominal pile diameters were about two to three times larger than the resistance along the non-grouted lengths. The ultimate shaft resistance for the pile lengths below the bidirectional cells reached an ultimate value after about 8 to 10 mm movement. The pile toe stress-movement responses to toe stiffness were soft with no tendency toward an ultimate value.

The seventeenth paper is A study on behavior and bearing capacity of soil-cement injected precast piles (SIP) by T.Dung. Nguyen, Duc.Long. Phung and D.A Ho: Recently, soil-cement injected precast pile (SIP) has been increasingly used in Vietnam as an alternative of driven PHC pile in difficult ground conditions or in urban areas to reduce noise from pile driving. However, since there haven't been a specific design guide, bearing capacity of SIP is empirically designed based on that of driven PHC pile. This paper presents an analysis on behavior and bearing capacity of SIP obtained from more than 10 SIP test piles in different locations in Vietnam. Test results indicated that bearing capacity of the SIPs were as much as 40 % lower than that of the corresponding driven PHC piles. Besides, empirical equations for shaft and toe resistance of the pile are suggested for practical applications in Vietnam.

The 18th paper is on Geo-CPT&Pile Database; Geotechnical, CPT/CPTu and Pile Loading Test Records. It is written by Abolfazl Eslami and Sara Moshfeghi: Measurements are a primary source of acquiring information in geotechnical engineering. Data sources include Non-Destructive Testing (NDT), in-situ penetration and laboratory testing, physical modelling as well as instrumentation and monitoring in the field. In recent decades, implementation of various in-situ penetration tests has played a crucial role for subsurface soil profiling. Specifically, cone and piezocone penetration test (CPT and CPTu) are more favoured due to rapid performance, accuracy and providing continuous records.

Apart from soil behaviour classification, in pile design, the cone penetrometer can be considered as a model pile, particularly, where deep foundations are to be constructed in soft to medium subsoil deposits. In addition, the inevitable application of deep foundations for important structures located on problematic soils mandates comprehensive investigations for optimum and simultaneously safe design.

Similar to other geotechnical issues, due to uncertainties in geomaterial properties and modelling, a detailed and precise data source can improve reliability indices. Accordingly, geotechnical databases are known as helpful tools in research and practical applications which facilitate quantifying the uncertainties. There are currently several databases in the realm of piling and CPT. A few number of well-known databases are Nottingham and Schmertmann (1978), Tumay and Fakhroo (1982), Briaud and Tucker (1988), Alsamman (1995), Eslami and Fellenius (1997), Titi and Abu-Farsakh (2004), and ZJU-ICL (2015).
A database has been compiled including pile load test with adjacent CPT records and related geotechnical information, namely AUT (Amirkabir University of Technology): Geo-CPT&Pile Database. It was developed in 2015 with an initial number of 466 case records, and at present updated to 600 plus case records which are partly accessible online. In this paper, after a brief review of existing CPT and pile databases, the specifications of the updated AUT: Geo-CPT&Pile Database as well as different classifications is presented.
Thus far, several processings have been carried out using this database based on some geotechnical aspects. Moshfeghi and Eslami (2018) worked on value engineering and deep foundations by performing risk analyses and evaluating optimum safety factors. Heidari and Eslami (2018) investigated the performance of direct CPT methods for pile capacity focusing on reliability-based approaches. Also, Askari Fateh et al. (2017) developed a new CPT-based approach for helical piles bearing capacity. Moreover, Moshfeghi and Eslami (2018) performed a reliability-based analysis to investigate the sufficiency of current CPT methods for design of drilled displacement piles. A summary of these database applications and processing are also introduced and addressed.

The nineteenth paper is on Behavior of displacement concrete pile under compressive loading by Jialin Zhou, Xin Zhang, Hongyu Qin and Erwin Oh: This paper provides the research of displacement precast piles through performing Static Load Tests (SLTs). A total number of 15 piles with various pile lengths were tested.

The twentieth paper is by Koji WATANABE and Toshimi. SUDO on In-situ Full Scale Load Tests and Estimation Method of Pile Resistance for Nodular Diaphragm Wall Supporting High-rise Tower: In recent years, the height and weight of buildings have increased. This trend is noticeable especially in the urban central areas of Japan. Both tension force and compression force occur in foundation such as pile foundations or wall foundations because of the overturning moments from earthquake and wind loads. Because of these situations, it is necessary to develop new types of foundations for high-rise superstructures. The nodular diaphragm wall is a new type of foundation with a nodular part at the middle section of the wall foundation. The purpose of this study was to evaluate the application of the nodular diaphragm wall for the high-rise tower. This paper firstly reviews foundations similar to the nodular diaphragm wall, secondly describes the outline of the high-rise tower, then presents the tension and compression load tests, and finally discusses the design formula for the nodular diaphragm wall.

The twenty first paper is by Joshua Ong & S.A. Tan on Reinterpretation of static pile load tests for the calibration of advanced soil models.

The twenty second paper is by Alessandro Mandolini & Raffaele Di Laora on Design of axially-loaded piles: experimental evidence from 400 field tests

Phung Duc Long

ACKNOWLEDGEMENTS

Ten papers are contained in this issue. The Guest Editor is Dr Phung Duc Long . No doubt the material contained herein would be most valuable to our profession. The editors have adequately described the contributions in the preface. They are to be congratulated for these contributions.

Dr. Teik Aun Ooi
Prof. San Shyan Lin
Prof. Kwet Yew Yong
Dr. Noppadol Phienwej
Prof. A. S. Balasubramaniam

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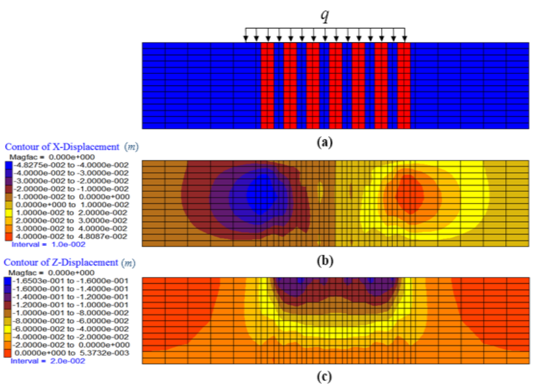
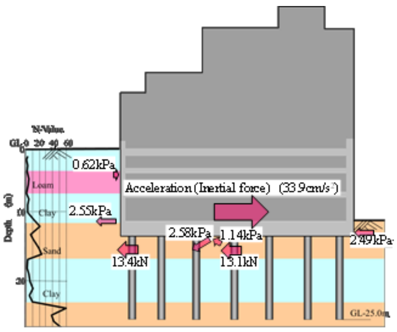


Behavior of foundation on end-bearing stone columns group reinforced soil: Seifeddine TABCHOUCHE ,



Seismic Observations on Piled Raft Foundation subjected to Unsymmetrical Earth Pressure during Far Earthquake and Near Earthquake
J. Hamada1 and K. Yamashita2

Long-term deformations of a historical church on the Anzer island, White sea:
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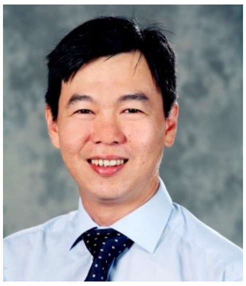
September 2018: Contributed Papers

Edited by:, San Shyan Lin, Erwin Oh & Ooi Teik Aun

San Shyan Lin

Prof. San-Shyan Lin graduated from Chung Yuan University with a BSCE degree in 1981. He then obtained his master degree from Utah State University, Logan, Utah in 1985 and his PhD from Washington University in St. Louis, Missouri in 1992. Before his teaching career at university, Dr. Lin served as an engineer at Taiwan Area National Expressway Engineering Bureau between1992 to1994. Dr. Lin has been serving at Department of Harbor and River Engineering (DHRE) of National Taiwan Ocean University (NTOU) since 1994. He was promoted as a full professor in 2000. Thereafter, he took some university duties by serving as the secretary-general at office of the secretariat between 2001 and 2003; the chairman of DHRE between 2005 and 2006; the acting dean of college of engineering in 2007 and the vice president of NTOU between 2006 and 2012.

Prof. Lin served as a committee member of committee A2K03-Foundations of Bridges and Other Structures of TRB, USA between 1995 and 2004. Currently, he is still serving as a committee member of TC-212 and ATC-1 of ISSMGE and as an editorial board member of four international journals. In addition, Dr. Lin also served as the president of Taiwan Geotechnical Society (2011-2013); Chairman of International Geosynthetics Society- West Pacific Regional Chapter (2002-2004); CEO of Sino-Geotechnics Foundation (2011-2014) etc. Dr. Lin received the distinguished alumnus award from Chung Yuan University in 2009 and the distinguish Engineering Professor Award from Taiwan Pavement Engineering Society in 2011. Prof. Lin's research and practical experiences have been dealt with deep foundations and geosynthetics.



Dr Oh is the Associate Dean (International) for Griffith School of Engineering and a Senior Lecturer in Geotechnical Engineering at Griffith University. He received his Bachelor and Master degrees from National Taiwan Ocean University, and his PhD from Griffith University. Dr Oh specialises in geotechnical and pavement engineering. He has co-authored over 100 refereed articles. His research interests include geotechnical issues for road infrastructure, soft clay behaviour, ground improvement techniques, and numerical modelling. Dr Oh had previously served as Chairman (2011 to 2013) and Committee member (2004 to 2015) for Engineers Australia Gold Coast regional group, Chairman (2012) and Committee member (2006 to 2012) for Australian Geomechanics Society Queensland Chapter.

Ooi Teik Aun

Ir. Dr. Teik Aun Ooi

Ir. Dr. Teik Aun Ooi obtained his Bachelor of Civil Engineering and Master of Engineering from Auckland Universiity in 1966 and 1968 respectively. He obtained his PhD from University of Sheffield in 1980. He was the Co - Organizing Chairman of the recently concluded SEAGC2016. He is the immediate Past President of the Southeast Asian Geotechnical Society (SEAGS), Founder Chairman of the Association of Geotechnical Societies in Southeast Asia (AGSSEA). He is a Past President of the Malaysian Institute of Arbitrators (MIArb). He is the Immediate Past ICE Country Representative for Malaysia (2000 - 2015), Founder Chairman of IEM Tunnelling and Underground Space Technical Division (TUSTD), Founder Chairman of IEM Consulting Engineering Special Interest Group (CESIG), He is an Honorary Fellow of The Institution of Engineers, Malaysia (Hon. FIEM), Fellow of the Institution of Civil Engineers (CEng FICE), Fellow of the MIArb (FMIArb), Fellow of Malaysian Society of Adjudicators (FMSA) and Fellow of Asean Academy of Engineering and Technology (FAAET). Dr. Ooi has fifty years of experience in the Construction Industry. He spent his initial fourteen years with the Public Works Department Malaysia before leaving to work in the private sector where he spent seventeen years working in the construction sector. He play major role in the Johore Baru Causeway widening and the design and construction of Senai Airport in 1970s. He was the Project manager for the Wisma Saberkas Building Project in Kuching in 1980s. He was Project Director for the Design and Construction supervision of the New Kuching Deep Water Port at Kampung Senari in 1990s.

He started his consultancy practice in 2000 specialising in Civil and Geotechnical Engineering works. Dr. Ooi is a practicing Consulting Engineer, An Expert Witness in Court and in Arbitration, An Accredited Checker, An Arbitrator and An Adjudicator. He is a member of the Accredited Checker Committee of the Board of Engineers, Malaysia. Dr. Ooi devoted much of his time in honorable public service in continuing education of engineers and development of Malaysia Annexes for Eurocode 7 and 8. He is an independent executive director of IEM Training Centre Sdn Bhd since 1992. In 2013 he was appointed executive director of the IEM Academy Sdn Bhd. He has been Organizing Secretary and Chairman of numerous IEM Workshops, Seminars, and Conferences since 1970s. He was responsible for forming five active ICE Student Chapters in Universities in Kuala Lumpur. Dr Ooi conducted touring lectures in geotechnical engineering to Malaysia, Vietnam, Thailand, Cambodia, Laos, Myanmar and Philippines. In Malaysia he was invited to deliver the prestigous 19th Professor Chin Fung Kee Memorable Lecture in 2009. He frequently delivered lectures to the final year University engineering students

GEOTECHNICAL ENGINEERING

PREFACE

This Issue contains ??? papers; the first paper is by Chernyshev Sergei N. on Long-term deformations of a historical church on the Anzer island, White sea: Current study is aimed at determining the rate of the sand ground dislocations near the ultimately steep slope. The purpose of this work to determine the velocity of the sandy soils on flat ground on extremely steep to slope. In order to determine the rate, we conducted periodical measurements of the width of the tensile fractures in the load-bearing walls of the building constructed in 1830. Building of the object and its restoration in the current century have led to the imperfect structure of the building, lacking steel ties in the brick walls, which should have been installed at different levels, specifically under the floor and at the level of the vault abutment. The absence of ties has resulted in rupturing of examined building due to tensioning of the moving foundation. The errors of the constructors have transformed this building into an experimental object. The direction and the velocity of the ground movement have been determined. Our results suggest that tensioning of the foundation should be considered when designing the structure of the buildings constructed on the sandy layer near bents.

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The second paper is by J. Hamada1 and K. Yamashita on Seismic Observations on Piled Raft Foundation subjected to Unsymmetrical Earth Pressure during Far Earthquake and Near Earthquake: Seismic observations on piled raft foundation subjected to unsymmetrical earth pressure have been conducted just after the 2011 off the Pacific coast of Tohoku Earthquake. The seismically monitored building is a seven-story building with three basement floors, subjected to unsymmetrical earth pressure, located in Tokyo, Japan. Accelerations of the building, dynamic sectional forces of the piles and dynamic earth pressures on both sides of the embedded foundation and those beneath the raft were observed during over 550 seismic events including an earthquake with a magnitude of M8.1. The maximum acceleration of 0.358 m/s2 was observed on the building foundation. Based on the seismic records, it was confirmed that a lateral inertial force of the building was transferred to the subsoil through the raft. Comparing to different seismic type, the bending moments on piles due to far earthquake having relatively long period were larger than those due to near earthquake. It was also found that the ratio of the lateral load carried by the piles to the lateral inertia force of the building was estimated to be about 10 to 30 %.

The third paper by M. Manzur Rahman and Mohammed K. Islam on Determination of Virgin Compression Destructuring Line Parameters for Natural Clays: Based on the destructuring framework proposed by Liu et al. (2015) preceded by the work by Liu and Carter (1999, 2000), the virgin compression destructuring behavior of fifteen natural soil published in various literature over the last seven decades in several locations around the globe have been studied. Two methods (i.e., graphtwelve ical and two reference point approach) to determine the parameters used in the equation of compression destructuring line (CDL) are proposed and examined by simulating the experimental data. Also, a systematic approach to find the yield pressure is suggested. The study concluded that CDL parameters obtained from graphical approach successfully predicted the compression behaviors of structured soil for most of the soil samples. Nonconformity occurs in case of two reference point approach in some cases. The two reference point approach is very helpful for a quick approximation of the CDL parameters because of its simplicity. Theoretically, two reference point method should be independent of the selection of the two point sets and always yield the same parameters but due to the uncertainty of the precision of experimental data, it varied. The author used and suggested a universal by taking furthest two points on the destructuring compression data as references. Also, the analytical approach to locate the yield pressure point is found very helpful. These methods eliminate the rigorous process of trial and error to find CDL parameters and other conventional processes to locate the yield pressure.

In the paper (fourth one) by H. Soltani-Jigheh and S.N. Tahaei Yaghoubi on Effect of Liquid Polymer on Properties of Fine-Grained Soils: One of the most useful methods for improving engineering characteristics of soils is soil stabilization by chemical additives like cement, lime and polymer materials. Since polymeric additives are more comfortable and effective, they have been considered widely in geotechnical projects in recent years. The current practice is to evaluate the effect of CBR-Plus polymer on physical and mechanical properties of fine-grained soils. For this purpose, CBR-Plus polymer was added to two high plasticity fine-grained soils. Afterward atterberg limits, compaction and consolidated undrained (CU) triaxial tests were carried out on them interpreting the results using scanning electron microscopy (SEM) images. Results show that CBR-Plus has insignificant effect on plasticity index and compaction characteristics of soils. Some amounts of CBR-Plus lead to increase in shear strength of specimens.

In fact, depending on the type of the soil, there is an optimum amount for this polymeric material in which the shear strength increases.

The fifth paper is on Geotechnical Aspects of Infrastructure Projects in Gypseous Soils by Safa Hussein Abd-Awn and Heba Qasim Hussein: This study is presented to investigate the behavior of single tension pile in collapsible soil (gypseous soil) by experimental work. The soil used 66% gypsum brought from Salah Al-Deen governorate in Iraq. The pile used is smooth steel. Slenderness ratios (L/D) are 10 and 20. The effect of the presence of gypsum content in the soil included in the study as well as the effect of rest time, and the effect of (L/D) to the pullout capacity of pile. The results showed that the pullout capacity of pile in gypseous soil is more than its capacity in sandy soil to about 64%, due to the presence of gypsum. When the rest time was increased, the pullout capacity of tension pile embedded in gypseous soil decreased. Increasing (L/D) ratio in gypseous soil 10 to 15% increases pullout capacity of pile about 65%, while increasing that ratio 15 to 20% increases pullout capacity of pile about 76%, and to about 75% when increasing 20 to 25%.

In the sixth paper is on Influence of Nano Copper Slag in Strength Behavior of Lime Stabilized Soil by M. Kirithika1 and V.K.Stalin: Nanotechnology has been widely used in many applications such as medical, electronics, and robotics also in geotechnical engineering area through stabilization of bore holes, grouting etc. In this paper, an attempt is made for understand the influence of nano copper slag (1%, 2% & 3%) on the index, compaction and Unconfined Compressive Strength (UCS) properties of natural soil (CH type) with and without lime stabilization for immediate and 7 days curing period. Results indicated that upto 1% of nano copper slag, there is an increment in UC strength of virgin soil and lime stabilised soil. Beyond 1% nano copper slag, there is a steep reduction in UC strength and increase of plasticity both in lime stabilised soil and virgin soil. The effect of lime is found to show more influence on large surface area of nano copper slag in natural soil. In lime stabilised soil, for both immediate and curing effect, with 1% of nano copper slag the maximum unconfined compressive strength was 38% and 106% higher than that of the virgin soil strength.

The seventh paper by Md Shofiqul Islam and Atikur Rahman is on Slope stability problem and Bio-engineering approach on slope protection: case study of Cox's Bazar area, Bangladesh: The slope stability problem of the six (06) locations in the Cox's Bazar district, Bangladesh were analyzed through laboratory measurement of the engineering properties of the soil samples, tensile strength of roots and numerical modeling using both limit equilibrium and finite element method. The modeling results show that the slopes are stable (FS value greater than 1) at the dry condition and the wet condition unless rocks are weathered. At the wet condition most of the slopes with loos soil are vulnerable for landslide and need supports to stabilize. We suggested the vegetal support (tap-rooted tree) to stabilize the vulnerable slopes of the study area. The experimental result shows that the roots of the local growing tap rooted trees (e.g., Chapalish, Korai, Gorjon, Telsur) grew linearly within a few years. The roots reached their length of 3-5 m within 4/5 years, yielding tensile strength of 70-80 MPa that enough to avoid the slope failure.

The subsequent paper eight in the series is by Nadia MEZNI and Mounir BOUASSIDA on Geotechnical characterization and behaviour of Tunis soft clay: Tunis soft clay being known as one of the most problematic soils has poor mechanical characteristics, high compressibility and exhibits fragile shear strength. This paper considers the geotechnical characterization of Tunis soft clay by compiling results from in situ and laboratory tests. Accordingly, some correlations are suggested. The assessment of observed behavior of Tunis soft clays in the zone of interchange ramps was investigated. The follow up of ramps behavior was performed for a period of three months. The evolution of settlement was monitored by rod settlement, hydraulic settlement and multi-points settlement. A plane strain model was built for numerical investigation conducted by Plaxis software to simulate the behavior of the ramp's embankment. Hardening Soft Soil Model (HSM) and Soft Soil Model (SSM) were adopted for the soft clay layer. The results showed an agreement between the predictions of the two models of the behavior of the soft clay. Using measured settlement the adopted behavior for Tunis soft clay is justified.

Mingyang Zhou1 and Kwong Soon Wong are the authors of the ninth paper on Strength of peat treated with peat ash: For construction on peaty ground, shallow peat layer is normally replaced by stiffer soil. The replaced peat may be burned into peat ash to reduce the volume. In this study, the potential of peat ash in improving the shear strength of peat was investigated using unconfined compression tests. It is found that peat ash has insignificant effect to the 7 days strength of peat. Peat ash increases the strength of peat by about 50% at Day 14. At Day 28 and 56, the effect of peat ash to strength of peat is comparable to the effect of cement, whereas the effect of cement is about 10% larger than that of peat ash. It is found that effect of peat ash in strengthening the peat become less significant with the present of cement.

The tenth paper is by Hui Su, Min Liang, Baowen Hu, ZhouXiang Xuan, Yue Xin, and Yi Zhu on Temperature-Stress Analysis of Rock-Shotcrete Structure under High Temperature Cooling Effect: Take the diversion tunnel located in geothermal area as engineering background, the coupled temperature-stress analysis of rock-shotcrete structure with high temperature was performed under immersion action of cold water. The Physical and simulation experiment show that temperature evolution of rock-shotcrete structure can be classified into three stages, which are initial rapid decay stage, deceleration decay stage and the equilibrium stage; The stress simulation shows that the sharp change of stress will occur in the shotcrete layer during the first stage, and maximum principal stress is mainly manifested as tensile stress, which will easily lead to tensile failure of the shotcrete layer; the displacement simulation shows that the rock-shotcrete structure takes on overall shrinkage deformation in each temperature stage, and it is most obvious for shotcrete layer. The deformation of rock plate will not stop until temperature reaches stable state. Such kind of deformation law will weaken constraint on the shotcrete material, and therefore lead to stress relief in the shotcrete layer.

A.Sridharan, Santhosh Kumar. T.G, Benny Mathews Abraham and Sobha Cyrus are the authors of the eleventh paper on Applicability of Hyperbolic Method for the Prediction of Shear Strength Parameters from Multistage Direct Shear Tests: Measurement of shear strength through a conventional direct box shear test involves the requirement of at least three identical soil specimens. The collection of samples and carrying out a number of tests is very expensive and time consuming. Multistage shear strength test provides a faster method for the determination of shear strength parameters of a soil through tests on a single sample. Earlier studies conclusively proved the effective use of multistage triaxial compression test to predict the shear strength of soils. In this paper an attempt is made to study the possibility of using multistage box shear tests on a single soil sample instead of the conventional box shear tests to predict the shear strength. Undrained direct shear tests conducted on three different soil types - medium sand, air dried Cochin marine clay and red earth showed very good agreement between the results of multistage and conventional box shear tests. It has been brought out that the stress- strain curve in the shear box test follows the hyperbolic form throughout the test. Hence, it is possible to predict the failure shear stress, knowing the stress-strain relationship for the initial portion only. Making use of this behavior, multistage tests were carried out on single sample changing the normal load after obtaining initial portion of stress- strain behaviour. It has been brought out that the conventional box shear test could be approximated to multistage box shear test using only one soil sample, avoiding the variability between three or four soil samples used in a conventional test. The test procedure has the distinct advantage of requiring only one sample coupled with large saving in time without much compromise on the accuracy.

12th in the series is the paper on Behavior of foundation on end-bearing stone columns group reinforced soil by Seifeddine TABCHOUCHE, Mounir BOUASSIDA and Mekki MELLAS: The prediction of the settlement of foundations on soil reinforced by a group of end-bearing stone columns was investigated. 3D numerical models with constant improvement area ratio are considered into two configurations. The first configuration consists of stone columns group located in regular triangular pattern. Whilst, an equivalent reinforcement by concentric crowns is used by the second configuration. Geotechnical parameters of the reinforced soil modeled by the Mohr Coulomb constitutive law are adopted from Tunisian case history. Numerical predictions of the settlement by the finite difference code FLAC 3D and analytical ones by Columns and COLANY software are compared. It has been verified that the settlement prediction by the unit cell model is underestimated in regard to predictions obtained by the 3D reinforced soil models. Elsewhere settlement predictions by the equivalent concentric crowns are close to those obtained by the corresponding models of stone columns group reinforcement. When the equivalent concentric crowns reinforcement is adopted the increase in contact area with the soft soil does not affect the settlement prediction when total adhesion is assumed along those interfaces. Using the FLAC 3D code, it is more suitable to handle the input data by the equivalent concentric crowns to perform the computations.

Editors:

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Erwin Oh
Ooi Teik Aun
KY Yong

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Fourteen papers are contained in this issue. No doubt the material contained herein would be most valuable to our profession. The editors have adequately described the contributions in the preface. They are to be congratulated for these contributions.

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Prof. San Shyan Lin
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GEOTECHNICAL ENGINEERING

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Edited by

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