

GEOTECHNICAL

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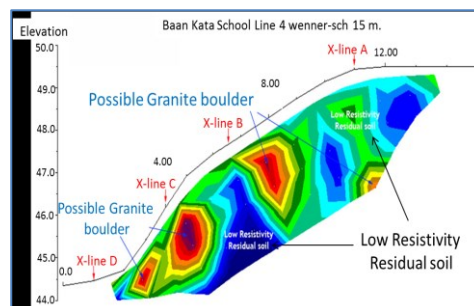
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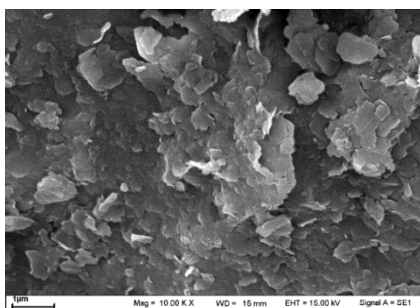
**Editors: Suched Likitlersuang, Suksun Horpibulsuk, Suttisak Soralump,
Tirawat Boonyatee Suchatvee Suwansawat, and Thanakorn Chompoorat**



Embankment completed construction
works at AIT (After Otha, 2015)



Results of electrical prospecting from
resistivity test (After Ohtsu et al., 2015)



SEM photograph of Bangkok clay
(After Por et al., 2015)



Dynamic creep test setup in wet condition
(After Chompoorat and Likitlersuang, 2015)

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PREFACE

Welcome to Geotechnical Engineering Journal of the Southeast Asian Geotechnical Society (SEAGS) and the Association of Geotechnical Societies in Southeast Asia (AGSSEA). It is our great pleasure to serve as the editors for the first issue of 2015 and also the special country issue of Thailand. Our editorial team consists of Prof. Suched Likitlersuang from Chulalongkorn University, Prof. Suksun Horpibulsuk from Suranaree University of Technology, Dr. Suttisak Soralump – President of Thai Geotechnical Society, Dr. Tirawat Boonyatee – Vice president of Thai Geotechnical Society, Prof. Suchatvee Suwansawat – President of Engineering Institute of Thailand, and Dr. Thanakorn Chompoorat from University of Phayao. We are also supported by Prof. A.S. Balasubramaniam as the editor-in-chief and Dr. Teik Aun Ooi as the president of SEAGS to launch this special issue. The rigorous blind peer-review process has been carried out by international reviewers, while every effort was carefully made to ensure the technical quality of the journal. We highly appreciate our reviewers for their time and effort.

The theme of this special issue is *Advances in Geotechnical Engineering for Infrastructure Developments in Thailand*. The articles cover a wide range of topics from theoretical soil mechanics to geotechnical applications for Thailand's infrastructure developments. This special issue of Geotechnical Engineering Journal of the SEAGS & AGSSEA is comprised of fourteen articles with a selection of authors from four countries including Australia, China, Japan and Thailand.

The first invited paper by Ohta (2015) presents consolidation settlement due to the embankment construction on soft Bangkok clay. The paper also acknowledges the technical communication with Dr. Surachat Sambhandaraksa related to consolidation settlement. Two papers (Ohtsu et al., 2015 and Jotisankasa et al., 2015) present field studies of slope stability due to rainfall in Thailand. The topics related to ground improvement for soft soil are still interested in this issue such as using chemical stabilisation (Horpibulsuk, et al., 2015, Fan, et al., 2015 and Julphunthong, 2015) and vacuum consolidation technique (Shibata et al., 2015). Two papers (Ukritchon and Boonyatee, 2015 and Horpibulsuk and Liu, 2015) related to soil modelling and its parameter calibration are included in this issue as well. Chompoorat and Likitlersuang (2015) summaries mechanical properties of hot mix asphalt for pavement design. Undrained shear strength of Bangkok clays from various laboratory techniques are discussed by Ratananikom et al. (2015). A review of pile foundation design on Bangkok subsoils is presented by Boonyatee et al. (2015). 3D finite element analysis of the potential use of piled raft foundation on Bangkok subsoils is proposed by Watcharasawe et al. (2015). Lastly, Por et al. (2015) presents a laboratory investigation of expansive soil behaviour.

We consider that this special issue summaries some recent advances in geotechnical engineering for infrastructure developments in Thailand. We also hope that it could make an important contribution to other countries in the Southeast Asia.

**Suched Likitlersuang
Thanakorn Chompoorat**

ACKNOWLEDGEMENT

At the very outset, we would like to acknowledge the skill of Prof. Suched Likitlersuang, who headed the team of Guest Editors in producing this excellent issue. This issue honours the late Dr. Surachat Sambhandaraksa a very long time friend of ours and a past president of the SEAGS. This is also the Thai country issue produced in such a short time, while some other country issues will only appear in 2016. The topics and the authors are adequately described in the Preface. The SEAGS and the AGSSEA as well as the Thai Geotechnical Society (TGS) are very grateful to the Editors, authors and reviewers for their excellent work.

A good teacher is often measured by the quality of his students. Dr. Surachat had graduated from Chulalongkorn University going to almost all the good universities to do doctoral studies. It is appropriate to have a brief biodata of Dr. Surachat.

Dr. Surachat Sambhandaraksa, a past president of the Southeast Asian Geotechnical Society (SEAGS) from 1996 to 1999. A modest and clever achiever, Surachat was the earlier colleague of late Dr. Chai Muktabhant and Prof. Vichien Tengamnuay at Chulalongkorn University. Surachat always had an international outlook with his early education at the University of New South Wales in Australia in 1967; then his master degree from the Asian Institute of Technology (AIT) in 1970; later Surachat went to the Northwestern University and finally obtained his Sc.D. degree from the Massachusetts Institute of Technology (MIT), the United States of America in 1977. When he returned to Chulalongkorn University, Surachat was also a lecturer much in demand at the AIT. He was actively involved in most of the major projects in Bangkok and Thailand. He has real world experience in geotechnical engineering practice with sound knowledge on the fundamentals of soil behaviour. His practice is in embankments and piled foundations. He was a much sort out consultant in Bangkok. At AIT, we needed a person like Surachat to teach our design courses. Surachat also taught a popular course for non-soil engineers and this is really popular. Surachat, received the Outstanding Award of the Teaching from Chulalongkorn University and was voted as the best Geotechnical Engineer in Thailand in 2006. He was also, the chairman of the organizing committee of the 15th Southeast Asian Geotechnical Conference held in Bangkok in November 2004. Popularly called as Sam at MIT, Surachat has a charming personality always joyful and friendly in nature. Surachat hails from a good family with his father as the professor of surgery at the Faculty of Medicine in Chulalongkorn University. We all miss him a lot and his premature death is a great loss to his family and friends.

Finally, Dr. Surachat is highly respected internationally, Prof. Harry Poulos made the comment as follows:

“Dr Surachat was a leading figure in Geotechnical engineering in Thailand for many years, and a person who was vastly experiencing in identifying and solving problems related to foundations in the often-challenging ground conditions in Bangkok. I first met him at one of the early Southeast Asian Geotechnical conferences, and it was quite clear that his knowledge of the characteristics of Bangkok soils was second to none, and that he was well-placed to advise clients on foundation design in these soils. He was also was a congenial host and dinner companion at a number of conferences held in Bangkok. Apart from his practical geotechnical skills, he was able to pass on his knowledge to many students who had the privilege of studying under him at Chulalongkorn University and at AIT. He was very proud of his educational background, first in Australia, and then at MIT, where he studied with some of the pioneers of soil mechanics such as Lambe, Ladd and Whitman. He achieved recognition for his expertise both in Thailand and in Southeast Asia more generally, and with his passing, the Southeast Asian region has lost one of its elder statesmen in the geotechnical profession.”

Finally, We thank the Guest Editors, the authors of the papers and the reviewers , who made the most valued contribution in making this Issue feasible.

K. Y. Yong
N . Phienwej
T. A. Ooi
A. S. Balasubramaniam

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March 2015 Issue: Special Country Issue of Thailand

– Dr. Surachat Sambhadharaksa Memorial Issue

Advances in Geotechnical Engineering for Infrastructure Developments in Thailand

**Edited by : Suched Likitlersuang, Suksun Horpibulsuk, Suttisak Soralump,
Tirawat Boonyatee Suchatvee Suwansawat, and Thanakorn Chompoorat**

Suched Likitlersuang

Suched Likitlersuang graduated with a bachelor degree in civil engineering from Chulalongkorn University in 1998 and received a master in geotechnical engineering from Asian Institute of Technology in 2000. He attained a doctorate in civil engineering from the University of Oxford in 2004. Suched is currently a full professor at the Department of Civil Engineering, Chulalongkorn University. He is members of the Thai Geotechnical Society and the Engineering Institute of Thailand. He is also an Editorial Board member of Geotechnical Research and serves as a Guest Editor of the Southeast Asian Geotechnical Society Journal special issue for Thailand. Suched has published over 70 articles in international conference proceedings and international journals. His research interests include constitutive modelling for geomaterial and asphaltic concrete, stress-strain characteristic of soils, numerical analysis in geomechanics, geo-environments, geotechnical earthquake engineering and soil bioengineering.

Thanakorn Chompoorat

Thanakorn Chompoorat was born in Thailand in 1980. He graduated the Bachelor degree in Civil Engineering from Srinakharinwirot University in 2003. He also received the Master and the Doctoral degrees in Geotechnical Engineering from Chulalongkorn University in 2005 and 2009 respectively. He is currently an Assistant Professor and Assistant Dean for Research and Academic Service of the Department of Civil Engineering, University of Phayao. Thanakorn is a member of the Thai Geotechnical Society as well as the Engineering Institute of Thailand and presently also serves as an Editorial Secretary of the Southeast Asian Geotechnical Society Journal special issue for Thailand. His main research interests are soil behaviour and pavement material behaviour, numerical analysis for soil and pavement material, and constitutive modelling and plasticity.

GEOTECHNICAL ENGINEERING

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TABLE OF CONTENTS

List of Papers

	<u>Page</u>
Settlement due to Consolidation <i>By H. Ohta</i>	01
A Simulation of Surface Runoff and Infiltration due to Torrential Rainfall Based on Field Monitoring Results at a Slope Comprising Weathered Granite <i>By H. Ohtsu, H. Masuda, T. Kitaoka, K. Takahashi, M. Yabe, S. Soralump and Y. Maeda</i>	12
Calcium Carbide Residue – A Cementing Agent for Sustainable Soil Stabilization <i>By S. Horpibulsuk, A. Kampala, C. Phetchuay, A. Udomchai and A. Arulrajah</i>	22
Soil Parameter Optimization of the NGI-ADP Constitutive Model for Bangkok Soft Clay <i>By B. Ukritchon and T. Boonyatee</i>	28
Investigation of Hot Mix Asphalt Behaviour for Mechanistic-Empirical Pavement Design in Tropical Countries <i>By T. Chompoorat and S. Likitlersuang</i>	37
Slope Stability and Pore-Water Pressure Regime in Response to Rainfall: A Case Study of Granitic Fill Slope in Northern Thailand <i>By A. Jotisankasa, K. Mahannopkul and A. Sawangsuriya</i>	45
Evaluation of the Hydraulic Conductivity of Clayey Soil Mixed with Calcium-Bentonite Using Oedometer Tests <i>By R.D. Fan, Y.J. Du, S.Y. Liu and Y.L. Yang</i>	55
Undrained Shear Strength of Very Soft to Medium Stiff Bangkok Clay from Various Laboratory Tests <i>By W. Ratananikom, S. Yimsiri and S. Likitlersuang</i>	64
A Review on Design of Pile Foundations in Bangkok <i>By T. Boonyatee, J. Tongjarukae, T. Uaworakunchai and B. Ukritchon</i>	76
Structured Cam Clay Model with Cementation Effect <i>By S. Horpibulsuk and M.D. Liu</i>	86
Evaluation of Strength of Soft Ground Improved by Vacuum Consolidation <i>By T. Shibata, S. Nishimura, M. Fujii and A. Murakami</i>	95
Chemical Stabilization of Loess in Northeast Thailand Using the Mixture of Calcined Marble Dust Waste and Sugarcane Bagasse Ash Waste <i>By P. Julphunthong</i>	103
Numerical Analyses of Piled Raft Foundation in Soft Soil Using 3D-FEM <i>By K. Watcharasawe, P. Kitiyodom and P. Jongpradist</i>	109
Investigation of Shrinkage and Swelling Behaviour of Expansive/Non-Expansive Clay Mixtures <i>By S. Por, S. Likitlersuang and S. Nishimura</i>	117

Cover Photographs:

1. Embankment completed construction works at AIT (After Otha, 2015)

2. Results of electrical prospecting from resistivity test (After Ohtsu et al., 2015)
3. SEM photograph of Bangkok clay (After Por et al., 2015)
4. Dynamic creep test setup in wet condition (After Chompoorat and Likitlersuang, 2015)

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Paper Contribution, Technical notes and Discussions

SEAGS & AGSSEA encourage the submission of scholarly and practice-oriented articles to its journal. The journal is published quarterly. Both sponsors of the journal, the Southeast Asian Geotechnical Society and the Association of Geotechnical Societies in Southeast Asia, promote the ideals and goals of the International Society of Soil Mechanics and Geotechnical Engineering in fostering communications, developing insights and enabling the advancement of the geotechnical engineering discipline. Thus the publishing ethics followed is similar to other leading geotechnical journals. Standard ethical behaviour of the authors, the editor and his editorial panel, the reviewers and the publishers is followed.

Before you submit an article, please review the guidelines stated herein for the manuscript preparation and submission procedures. Paper template is available upon request.

Geotechnical Engineering Journal accepts submissions via electronic. The manuscript file (text, tables and figures) in both words and pdf format together with the submission letter should be submitted to the Secretariat and copied to the Editor-in-Chief, Geotechnical Engineering Journal, c/o School of Engineering and Technology, Asian Institute of Technology, Room no. 211, AIT Library, Asian Institute of Technology, P.O. Box 4, Klong Luang, Pathumthani 12120, Thailand. Email: seags@ait.ac.th. Papers under review, accepted for publication or published elsewhere are not accepted. The guidelines for author are as follows:-

1. The manuscript including abstract of not more than 150 words and references must be typed in Times New Roman 9 on one side of A4 paper with a margin of 25 mm on each side. The abstract should be written clearly stating the purpose, scope of work and procedure adopted together with the major findings including a summary of the conclusions.
2. The paper title must not exceed 70 characters including spaces.
3. The maximum length of papers in the print format of the Journal is 12 two-column pages in single-spaced in Times New Roman 9 including figures and tables. A Journal page contains approximately 1,040 words. Authors can approximate manuscript length by counting the number of words on a typical manuscript page and multiplying that by the number of total pages (except for tables and figures). Add word-equivalents for figures and tables by estimating the portion of the journal page each will occupy when reduced to fit on a 160 mm x 240 mm journal page. A figure reduced to one-quarter of a page would be 260 word-equivalents. When reduced, the figure must be legible and its type size no smaller than 6 point font (after reduction).
4. Figures: Line art should be submitted in black ink or laser printed; halftones and color should be original glossy art. Figures should be submitted at final width i.e. 90 mm for one column and 185 mm for two columns. The font of the legends should be in Times New Roman and should use capital letters for the first letter of the first word only and use lower case for the rest of the words. Background screening and grids are not acceptable.
5. Each table must be typed on one side of a single sheet of paper.
6. All mathematics must be typewritten and special symbols identified. Letter symbols should be defined when they first appear.
7. The paper must have an introduction and end with a set of conclusions.
8. Practical applications should be included, if appropriate.
9. If experimental data and/or relations fitted to measurements are presented, the uncertainty of the results must be stated. The uncertainty must include both systematic (bias) errors and imprecisions.
10. Authors need not be Society members. Each author's full name, Society membership grade (if applicable), present title and affiliation and complete mailing address must appear as a footnote at the bottom of the first page of the paper.
11. Journal papers submitted are subject to peer review before acceptance for publication.
12. Each author must use SI (International System) units and units acceptable in SI. Other units may be given in parentheses or in an appendix.
13. Maximum of five keywords should be given.
14. REFERENCES

American Petroleum Institute (API) (1993). Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms – Working Stress Design, API Recommended Practice 2AWSD (RP 2A-WSD), 20th edition, 1993, p191

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Finn WDL and Fujita N. (2002). "Piles in liquefiable soils: seismic analysis and design issues," Soil Dynamics and Earthquake Engineering, 22, Issues 9-12, pp731-742

15. Discussions on a published paper shall be made in the same format and submitted within six months of its appearance and closing discussion will be published within twelve months.

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Asian Institute of Technology
P.O. Box 4, Klong Luang
Pathumthani 12120, THAILAND
Email: seags@ait.ac.th
Website: <http://www.seags.ait.ac.th>***

***Ir. Kenny Yee
Hon. Secretary General
Association of Geotechnical Societies in Southeast Asia
E-mail: kenny.yeeks@gmail.com
Website: <http://www.agssea.org>***

***IEM Training Centre Sdn. Bhd.
No. 33-1A, Jalan SS 52/18
P.O. Box 224 (Jalan Sultan)
46200 Petaling Jaya, Selangor Darul Ehsan, MALAYSIA
Tel: (60) 03 7958 6851
Fax: (60) 03 79582851
E-mail: choy.iemtc@gmail.com
Website: <http://www.iemtc.com>***

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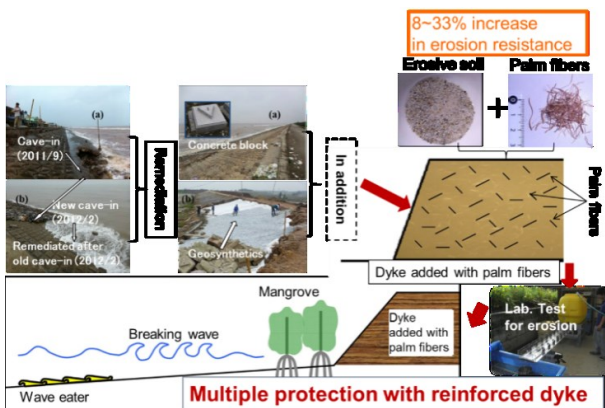
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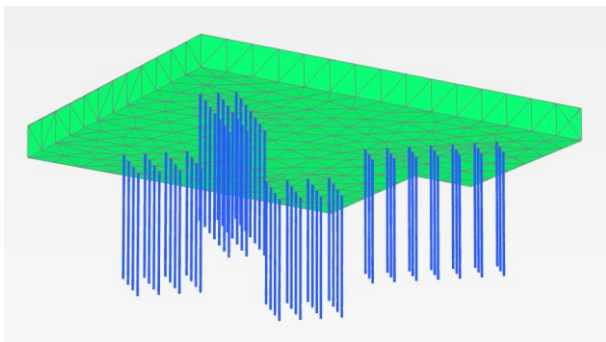
Multiple protective measures used in coastal areas

(After Yasuhara *et al.*, 2016)



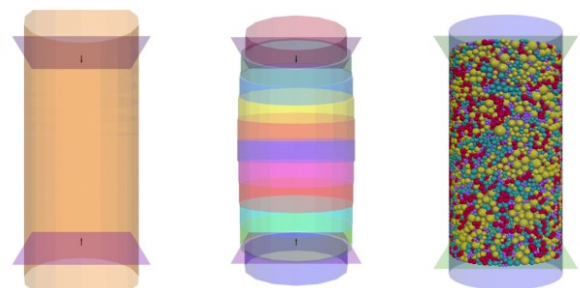
Example of erosional scene of river bank in the Mekong Delta

(After Yasuhara *et al.*, 2016)



Plaxis 3D piled raft foundation model

(After Phung Duc Long, 2016)



Geometry of DEM models

(After Nguyen Quang Tuan and H. Konietzky, 2016)

GEOTECHNICAL ENGINEERING

PREFACE

This journal issue was edited and contributed from works in Vietnam by Vietnamese authors and other popular persons. Sixteen papers are contained in this issue. Dr. Phung Duc Long is the lead editor. His Vietnamese team included: Dr. Pham Van Long, Dr. Pham Huy Giao, Mr. Mai Trieu Quang, Dr. Nguyen Anh Minh, Dr. Vu Quang Hung, and Dr. Vu The Manh.

The construction field in Vietnam has been under a very fast development. More than ten years ago the first 30-storey tower appeared in Vietnam. Today, the height has reached to 70-80 floors. During the last decade many tall towers, long bridges, deep tunnels, large hydro-power dams, large airport and harbours, etc have appeared in Vietnam. Thousands of kilometers of highway have been constructed. New metro projects have been started both in Hanoi and Ho Chi Minh City. It is understandable why geotechnical engineering has recently developed very fast in Vietnam.

The issue's major topics relate to piled raft foundations; piled foundations for storage tanks; pile group settlements; coastal and riverine erosion in the context of climate change; soil characterization for land subsidence evaluation for MRT projects; discrete modelling of excavation in fractured rock; settlement management for urban tunnels; evaluation of performance of diaphragm walls; study on clayey soils using piezocone; DEM simulations of medium dense sand in triaxial apparatus; characteristic of unsaturated soil of earth fill dams; ground improvement using soil-cement columns/deep mixing method; and ground improvement with preloading, and PVD and vacuum pressure.

Phung Duc Long (paper No.1) has made a detailed study on pile raft foundation in which the piles are used for reducing settlement, not for taking the total load from superstructure as in the conventional pile foundations. The results from his field model test, which strongly supports the concept of settlement-reducers, are reviewed. Basing on the experiment, a simplified design method is proposed. In the paper, the method is used for the conceptual design of a large high-rise building complex. In combination with FEM, the simplified method gives a reliable tool for conceptual design of piled-raft foundations. PLAXIS 3D is used for modelling both the piled and un-piled foundations in the study.

Yasuhara *et al*, (paper No.2) describe climate change related disasters such as erosion along riverine and coastal areas of the Mekong Delta in the South Vietnam. Also, the red river delta in the north is expected to be exacerbated by land subsidence, sea-level rise (SLR), and magnified typhoons. Adaptation to severe erosion is expected to respond to regional circumstances and the demands of local residents. Based on the expectations outlined above, for soft adaptation, attempts were made to conduct perception surveys of local residents, in addition to field surveys of erosion at riverside and coastal areas using an un-crewed aerial vehicle (UAV). Furthermore, for hard adaptation, a proposal is made to conduct pilot field tests at the coast for reinforcing coastal dykes using the combined technique of locally available materials with cost-saving eco-geosynthetics in addition to application of ICT. This paper explains the possibility of smart adaptation combining soft and hard adaptation to reduce severe coastal and riverine erosion in the Vietnamese deltas.

Nguyen, H. M., Fellenius, B.H., Puppala, A.J. Aravind, P., and Tran, Q.T. (paper No.3) introduce bidirectional static loading tests on two shaft-grouted barrette piles of the 40-storey Exim Bank Building in Ho Chi Minh City, Vietnam. Simulation of the measured load-movement response indicated that the shaft resistance response was hyperbolic. The test schedule was interrupted by unloading/reloading cycles, which disturbed the gage data and included uneven load-holding durations which exacerbated the analysis difficulty.

Pham Huy Giao and Ta Thi Thoang (paper No.4) have an excellent paper on soil characterization and land subsidence prediction for the first MRT line in HCM city to meet the transportation needs of a fast growing population and rapid urbanization. Being located in the Sai Gon-Dong Nai delta HCM city area has low elevations and is underlain by a sequence of clayey, silty and sandy soil layers. Land subsidence due to groundwater extraction had been suspected and observed in HCM city. In this study, geotechnical characterization of the subsoil along the first MRT line was carried out. Prediction of land subsidence along this MRT line was conducted using a FEM consolidation code.

Shiwakoti and Manai (paper No.5) examine the application of deep cement-mixing technique in improving engineering properties of soft grounds at nine different sites in southern Vietnam's typical soft soil deposits. The exercise consisted of running a series of laboratory tests on undisturbed soil samples and their mixes with cement and field trials, followed by field application of 500,000 m cement treated columns with 600mm diameter, using Dry Jet Mixing technique. After the field trials and applications, cores were extracted from the treated grounds to evaluate improvement in their engineering characteristics. Both the laboratory and the field results revealed a drastic enhancement in strength, stiffness, and permeability of the treated soft soils.

Over-consolidation ratio (OCR) is an important geotechnical parameter for predicting undrained shear strength, lateral pressure ratio and settlement of clayey ground. Piezocone studies were made by **Bui Truong Son, Le Hong Quang and Lam Ngoc Qui** (paper No.6). In Southern Vietnam, a thick layer of saturated soft clays distributes throughout all the area. It includes Mekong (in Ca Mau province) and Dong Nai (in HCMC and Vung Tau) alluvial deposits. Below the soft clayey layer, there is a layer of either stiff to very stiff clay or fine sand. Based on the reliable data of consolidation test results of samples taken by piston tube and piezocone, relationship between over-consolidation ratio and normalized penetration resistant is established and analysed.

Phan To Anh Vu (paper No.7) studied the ground improvement using soil-cement method: A case study with laboratory testing and in-situ verification for a Highway project in Southern Vietnam. This article presents the experimental unconfined compressive strength results of soil-cement columns to improve the soft soil gained by Tan Son Nhat-Binh Loi Outer Ring Road Project, located in Ho Chi Minh City, Vietnam. The laboratory test results revealed that the Stable Soil cement has a greater unconfined compressive strength than tower (60%) slag cement. In addition, cement-soil samples obtained from in-situ indicated that the target cement content of 240 kg/m³ was satisfied not only a required compressive strength (>24 kgf/cm²) but also a low-cost. The obtained results are expected to provide an experience for further design and construction in Ho Chi Minh City and its vicinity.

Bengt Fellenius and Mauricio Ochoa (paper No.8) write on the use of piled foundations for wide storage tanks. The authors have analyzed five case records involving wide piled foundations and show that the foundation settlement can be modeled as a flexible raft placed at the pile toe level with the foundation load distributed according to Boussinesq stress distribution and that the capacity of an individual pile is not relevant to the foundation performance. Differential settlement between the perimeter and interior piles and the effect of drag force and downdrag are discussed. The limitation of drag force as affected by the pile spacing and the weight of the soil in between the interior piles is addressed.

Tran Thi Thu Hang and Frederic Dubois (paper No.9) deal with discrete modelling of excavation in fractured rock by NSCD method. The presence of the network of discontinuities on intact rock is a special feature of nature rock masses. Non Smooth Contact Dynamics method (NSCD) is a discrete numerical method that owns many strong advantages of the study on granular materials and has been used recently in rock engineering. LMGC90, open-sourced software built on NSCD, has demonstrated a robust capacity in the modelling and mechanical analysis of diverse environments, masonry and rock included. In this study, a numerical modelling of a multi-phase-excavation in fractured rock was realized. The simulation of the tunnelling with the consideration of the state of the excavation and its neighbouring rock blocks, during and after the excavation schedule, and at each excavation phase was conducted. The obtained mechanical behaviours of the model were analysed, and three failure mechanisms of the excavation vicinity during the tunnelling was aimed. The observed phenomena showed typical effects of two components of the rock mass (rock structure and rock material) to the stability of the excavation and the host rock mass.

Duong Diep Thuy, Pham Quang Hung, and Le Thiet Trung (paper No.10) studied the pile groups in Vietnam using a method for estimating the pile group settlement considering the distribution of pile shaft friction, called SDF. For illustrating the proposed method is used for a full scaled experimental model by Koizumi et al (1967), for a field model test by Phung (1993) and for two case histories in Vietnam, Ca Mau Fertilizer Plant, and Ecopark Tower 2. Comparison of the calculated settlements with the measurement results shows that the SDF method provided a good prediction for all the studied cases.

Nguyen Quang Tuan and H. Konietzky (paper No.11) deals with the mechanical behaviour of Hai Duong Medium dense sand in triaxial test and its simulation using DEM. Numerical simulations of the drained triaxial behaviour of medium sand, a typical constructional soil material and widely used in Northern Provinces of Vietnam, were performed using discrete element method (DEM). The sand was simulated based on spherical particles using PFC3D with a non-linear contact model including rolling resistance. The calibrated simulations show that the DEM model is able to capture the mechanical behaviour of sand. The effects of different microscopic parameters on the macroscopic behaviour of the sand were investigated.

Tran The Truyen, Nguyen Van Hung, and Tran N. Hoa (paper No.12) studied the influence of geometrical parameters of soil cement columns on the settlement of embankments on reinforced soft soil. Deep Mixing Method (DMM) is a widely used soft soil improvement method in the construction of road,

port, and tunnel foundations, etc. Deep mixing of cement with soil and water, forming Soil Cement Columns (SCC) in situ, has been applied in many projects in Vietnam in recent years; it has proved many advantages compared with other applied methods in the site. At present, Vietnamese engineers are concerned with finding out recommendations for an optimal choice of SCC scheme. This paper analyzes the influence of main geometrical parameters of SCC including the length, the diameter, and the spacing on the behavior of reinforced soft soils in some construction projects in Vietnam. The results will be an important basis for recommendations on the choice of rational schemes of SCC for soft soil improvement in Vietnam.

Benson Hsiung, Dao Sy Dan and William Cheang (paper No.13) evaluated the performance of diaphragm walls by wall deflection paths for deep excavations in Central Hanoi. The objective of this paper is to evaluate the performance of diaphragm walls by wall deflection paths for deep excavations in Central Hanoi. PLAXIS 2D was used for 2D finite element analyses in this paper. A benchmark analysis was first conducted on the excavation to verify the validity of material models and their input parameters for predicting wall deflections. The reference envelopes of wall deflection paths were then delivered for various conditions of deep excavations in Central Hanoi. Considering the current prediction, up to 72 mm of the maximum lateral wall displacement was predicted for an excavation with a 21.9 m depth. Reference envelopes of excavations have been developed and discussed in various conditions of the excavation. It is found that the maximum lateral wall displacement at the first stage of excavation is roughly inversely proportional to the Young's moduli of soils. Changing the wall thickness leads to the limited difference in reference envelope at shallow excavation stages, but this may not be correct when the excavation goes deeper.

Hoang Hiep and Pham Huy Giao (paper No.14) studied the effect of vacuum pressure distribution on settlement analysis results for an improved thick soft clay deposit at Sai Gon-Hiep Phuoc terminal port, South of Vietnam. In this study an approach of settlement analysis using a FORTRAN code was proposed to successfully simulate the large consolidation settlement of a thick soft clay deposit, improved by combination of preloading, PVD and vacuum pressure for Sai Gon-Hiep Phuoc (SGHP) project. Geotechnical characterization of the subsoil profile underlying the project site was carefully done to provide input data for settlement analysis, in which a particular focus was given on studying the vacuum pressure distribution along the 35-m deep PVD. It was found that the coefficient of vacuum pressure distribution (kP) from 0.85 to 1.0 gave the best estimation of the time-dependent total primary settlement as embankment construction goes in addition to a smear effect $RS = 3.0$. The increasing trend of kP with time might be explained by the fact that for the later stages of loading the vacuum pressure could spread more to the depth.

Nguyen Thi Ngoc Huong and Trinh Minh Thu (paper No.15) studied the Characteristic of Unsaturated Soil of Earth Fill Dams in Vietnam. Earth dams in Vietnam, especially earth dams at the central part of Vietnam, are generally made using in-situ soils having low clay content. The knowledge, experience, calculation theory, apparatus etc, for unsaturated soils in Vietnam are still very limited, especially the studies of the influences of the shear strength of unsaturated soils to the stability of earthen structures. Therefore, study on the soil-water characteristic curve, shear strength and coefficient of permeability versus different matric suction for Vietnamese soil is an urgent task. This study shows that when the

matric suction in the soil changes, the effective cohesion c' would also change; however the internal friction angle is almost unchanged for some types of soil in Vietnam. The experimental results can be applied to study the effect of unsaturated soil to the factor of safety of the slope.

Finally paper by **Alain Guilloux and Hervé Le Bissonnais** (paper No.16) is on the management of settlements for urban tunnels. The TOULON highway tunnel is located in a very dense urban environment, and a much complex geology. The excavated section is about 120 m^2 and the depth is in the range 15-35 m. The aim of the paper is to show how a great attention was paid to the settlements control: at the design stage through soils investigations, survey of existing constructions in regards to their sensibility to tunnel induced settlement, definition of settlements thresholds, and choice of ground pre-reinforcement techniques; during the construction, by heavy monitoring of deformations and continuous adaptation of the supports to the actual settlements and buildings behaviour.

This issue contains sixteen papers which are related to the Vietnam soil conditions and contribute to the advancement of geotechnics, and are all written by the Vietnamese authors, about projects in Vietnam, or the topics that Vietnam are facing. It is hoped that the issue will demonstrate how the authors have made their studies geared in a manner useful to geotechnical engineers in Vietnam and elsewhere.

Phung Duc Long

ACKNOWLEDGEMENT

It is a genuine pleasure to note that this Issue contains sixteen excellent contributions as made by authors mostly from Vietnam in using modern developments in Geotechnics relevant and applicable to Vietnamese soil and rock conditions. They are mostly practical in nature and is an excellent example of how research be conducted useful to our geotechnical profession in practice. Dr. PHUNG Duc Long is the lead editor. His Vietnamese team included: Dr. Pham Van Long, Dr. Pham Huy Giao, Mr. Mai Trieu Quang, Dr. Nguyen Anh Minh, Dr. Vu Quang Hung, and Dr. Vu The Manh.

The Preface by Dr. Phung adequately covers the details of the contributions by the authors. Vietnam is an important arm of our AGSSEA and has developed enormously in the recent years with tall buildings, coastal structures, highways and expressways, airport developments etc. It is a paradise for geotechnical engineers. We are all most grateful to Dr. Phung and his team. This issue demonstrates the future of Geotechnics extend to all member countries of AGSSEA and beyond. The successful conferences and symposia organised by the Vietnamese Society for Soil Mechanics and Geotechnical Engineering (VSSMGE) is also worthy of praise.

K. Y. Yong

N . Phienwej

T. A. Ooi

A. S. Balasubramaniam

GEOTECHNICAL ENGINEERING

March-2016 Issue: Vietnam Special Issue
Edited by Dr. Phung Duc Long & Prof. San Shyan Lin



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.



Prof. San-Shyan Lin

Dr. Lin is a Professor at Department of Harbor and River Engineering of National Taiwan Ocean University in Taiwan. He received his Ph.D. degree in Civil Engineering from Washington University in St. Louis, Missouri USA in 1992. Dr. Lin was an engineer at Taiwan Area National Expressway Engineering Bureau from 1992 to 1994. Prof. Lin also served as TRB A2K03 Committee member on Foundations of Bridges and Other Structures between 1995 and 2004. He is also serving as committee member of TC-212 and ATC-1 of ISSMGE and as editorial board member of four major international journals in geotechnical engineering.

Prof. Lin's research and practical experiences have been dealt with static and dynamic behaviour of deep foundations, ground improvement and effects of scouring on bridge foundations. In the past decades, he was involved in many research projects such as interpretation of pile load testing results due to axial, lateral, or combined loading; effect of soil liquefaction on performance of pile foundation in sand; seismic effect of pile foundations; performance of suction pile in sand or in clay; and effect of scouring on performance of pile and caisson foundations etc. Prof. Lin has published more than 110 peer-reviewed journal papers and conference papers. One of his published Journal papers dealing with cyclic lateral loading effect on permanent strain of deep foundation due to cyclic lateral loading has been cited more than 60 times in Google academic website by many international researchers working on wind turbine foundations.

GEOTECHNICAL ENGINEERING

March 2016: VIETNAM SPECIAL ISSUE

Editors: Dr. Phung Duc Long & San Shyan Lin

TABLE OF CONTENTS

<u>List of Papers</u>	<u>Page</u>
1: Prediction of Piled Raft Foundation Settlement – A Case Study By Phung Duc Long	01-06
2: Geotechnical Adaptation to the Vietnamese Coastal and Riverine Erosion in the Context of Climate Change By K. Yasuhara, M. Tamura, Trinh Cong Van and Do Minh Duc	07-14
3: Bidirectional Tests on Two Shaft-Grouted Barrette Piles in Mekong Delta, Vietnam By H. M. Nguyen, B. H. Fellenius, A. J. Puppala, P. Aravind, and Q. T. Tran	15-25
4: Soil Characterization and Land Subsidence Prediction for the First MRT Line in HCM City By Pham Huy Giao and Ta Thi Thoang	26-31
5: Soft Ground Improvement by Deep Cement-Mixing Technique in Southern Vietnam By Dinesh Raj Shiwakoti and Ryuji Manai	32-38
6: Over Consolidation Feature of Clayey Soils in Southern Vietnam According to Piezocone By Bui Truong Son, Le Hong Quang, Lam Ngoc Qui	39-44
7: Ground Improvement Using Soil-Cement Method: A Case Study with Laboratory Testing and In-Situ Verification for a Highway Project in Southern Vietnam By Phan To Anh Vu	45-49
8: Wide Storage Tanks on Piled Foundations By Bengt H. Fellenius and Mauricio Ochoa	50-61
9: Discrete Modelling of Excavation in Fractured Rock by NSCD Method By Tran Thi Thu Hang and Frederic Dubois	62-68
10: A Method for Estimating Pile Group Settlement Considering Distribution of Pile Shaft Friction (SDF) – Application for Pile Groups in Vietnam By Duong Diep Thuy, Pham Quang Hung, and Le Thiet Trung	69-78
11: Mechanical behaviour of Hai Duong Medium Sand in Triaxial Test and its DEM Simulations By Nguyen Quang Tuan and Heinz Konietzky	79-86
12: Influence of Geometrical Parameters of Soil-Cement Columns on the Average Settlement of	87-91

Embankment on Reinforced Soft Soil – Numerical Analysis

By Tran The Truyen, Nguyen Van Hung, and Tran N. Hoa

- 13: Evaluation of Performance of Diaphragm Walls by Wall Deflection Paths for Deep Excavations in Central Ha Noi 92-99

By Benson Hsiung, Dao Sy Dan, and William Cheang

- 14: Effect of Vacuum Pressure Distribution on Settlement Analysis Results for an Improved Thick Soft Clay Deposit 100-105

at Sai Gon-Hiep Phuoc Terminal Port, South of Vietnam

By Hoang Hiep and Pham Huy Giao

- 15: Characteristic of Unsaturated Soil of Earth Fill Dams in Vietnam 106-117

By Nguyen Thi Ngoc Huong and Trinh Minh Thu

- 16: Settlement management for urban tunnels: an example from France 118-125

By Alain Guilloux and Hervé Le Bissonnais

Cover Photographs:

1. Multiple protective measures used in coastal areas (After Yasuhara et al. June 2016)
2. Example of erosional scene of river bank in the Mekong Delta (After Yasuhara et al. June 2016)
3. Plaxis 3D piled raft foundation model (After Phung Duc Long June 2016)
4. Geometry of DEM models (After N.Q. Tuan and H. Konietzky June 2016)

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Editor: Prof. Meei-Ling Lin



Satellite Image of the Taipei Basin
(After Yang, Wong and Hwang, 2016)



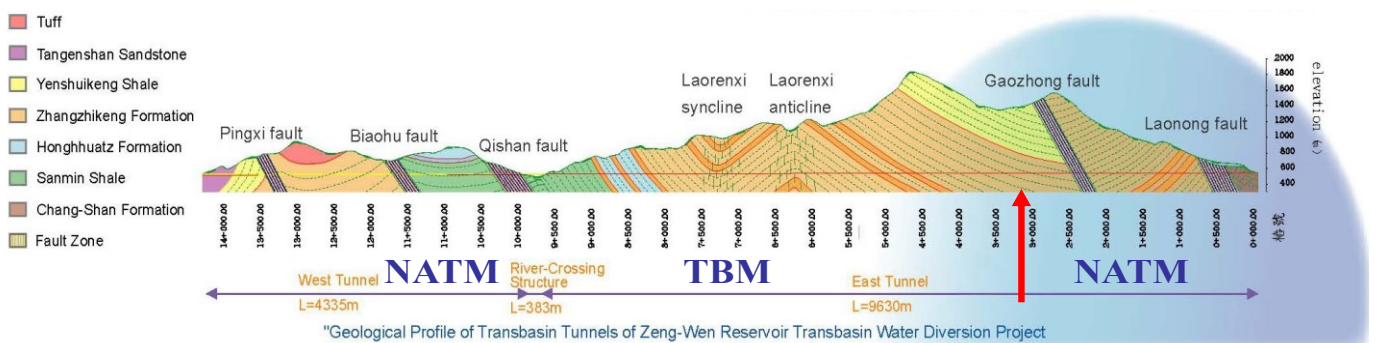
(b) Before typhoon



(a) After typhoon

Sedimentation of Typhoon Morakot on Wanda Reservoir in central Taiwan.

(After Lee, Wang, Chang Lien and Huang, 2016)



Geological profile along tunnels in TDT project (After Lee, Wang, Chang, Lien and Huang, 2016)

GEOTECHNICAL ENGINEERING

GEOTECHNICAL ENGINEERING

PREFACE

This Issue contains thirteen excellent papers as the country issue from Chinese Taipei Geotechnical Society (CTGS). It is an example of contributions from leading private sectors in Taiwan and also academics.

The first paper by Lee et al deals with the topic of rock tunnelling applied to steady water resources supply in Taiwan, challenges and examples. The authors deal with increasing soil erosion and slope collapse in some catchment area in Taiwan in the past decade. Also, increased sedimentation rates of the reservoirs reducing the effective capacity, and severely affecting the steady water supply. Multiple measures have been proposed for stabilizing the water supply. Tunnelling in the catchment area, even close to a dam, represents serious environmental and engineering risks. The authors present two cases of rock tunnelling as applied to steady water resources supply. Challenges and some distinctive issues, such as the presence of a high-temperature ground, a combustible gas emission ground, and potential instability of rock wedges caused by large underground excavation, are discussed. The authors then present countermeasures with a clever design of an elephant-trunk intake pipe to release turbid water. State-of-the-art tunnelling through rock and some innovative tunnelling technologies are utilized in these two cases.

The second paper by Chiu et al deals with the interesting topic of the state-of-the-art of tunnel maintenance in Taiwan and challenges to sustainable development. Tunnel construction in Taiwan started as early as the late nineteenth century; within the last 125 years, tunnel maintenance in Taiwan went through several stages. In early years engineers dealt with tunnel excavation. Now tunnel inspections, repairs and reinforcement were performed only when serious damages were observed. As the number of damaged tunnels increased, investigations revealed that the degradation of tunnels in Taiwan is inevitable and usually occurred in an exceptionally short period. Frequent earthquakes, a high ground water level and poorly cemented rock masses provide an environment for such degradation. To adapt more effectively to the environment, tunnel maintenance looked at the entire life cycle of a tunnel. Thus the diagnostic methods have demonstrated to be useful in enhancing the sustainable operation of tunnels.

An interesting contribution by Wang et al dealt with rock tunnel –shaft intersection in projects in Taiwan. The construction of an intersection between a shaft and a rock tunnel is a three-dimensional problem, and

requires more complex excavation and support methods than those used in conventional two-dimensional tunnel construction. The paper considered examples of rock tunnelling in Taiwan, and the construction of intersections between shafts and tunnels. Data are collected from case histories first, and the excavation sequences are classified. Then challenges as encountered to secure construction of the intersections of shafts and tunnels are examined, including the significant scale effects of rock masses on excavations; difficulties in controlling rock deformation near the intersections, and groundwater ingress are also discussed. Strategies and countermeasures as applied to overcome these difficulties in recent projects, and their effectiveness is investigated. Finally, the state-of-the-art design and construction of intersections between shafts and tunnels in Taiwan are presented.

The fourth paper by Hsiao et al dealt with the influence of peak strength degradation in assessing the stability of tunnels in hard rocks. Tunnelling depths are increasing rapidly in Taiwan. The effect of brittle failure on hard rock tunnelling is, however, rarely studied. In this paper, a study is carried out on the importance of the post-peak behaviour using Hoek-Brown failure criterion is investigated; through strength loss experimental studies, a relationship between strength loss parameter and confining stress is established. Subsequently, a numerical analysis model (so-called strength degradation model), is proposed and applied to predict the impact of the post-peak strength degradation on an actual tunnel. The analysis showed that the effect of the post-peak strength degradation on deformation during excavation is becoming more and more pronounced with increasing depth of tunnels. Severe deformation due to the excavation may endanger the tunnel stability during construction in deep overburden. Thus the strength degradation beyond brittle failure shall play an exceptionally important role in the stability of deep tunnelling.

The fifth paper by Hwang et al is on the deep excavations in Taipei Basin and the performance of diaphragm walls. Since movements of diaphragm walls are reduced by the presence of existing underground structures in the vicinity of excavation, comparison of the observed wall deflections with the results obtained by using two-dimensional analyses may lead to erroneous conclusions. Similarly, additions to diaphragm walls, such as buttresses, station entrances, ventilation shafts, etc., will also tend to reduce wall deflections. Thus the authors recommend to compare the results of two-dimensional analyses with the upper envelopes, designated as “reference envelope”, of a family of wall deflection paths of the same geometry of excavation and the same characteristics of the retaining system. Inclinator readings obtained at Shandao Temple Station of the Bannan Line of Taipei Metro were studied to establish the relationship between wall deflections and depth of excavations. The results are verified by numerical analyses using PLAXIS computer software. Reference envelopes were then developed for estimating maximum wall deflections; and charts were established for correcting inclinometer readings to account for the movement at diaphragm wall toes. The authors found that the

width of excavation has significant influence on wall deflections and toe movements. Additionally, the consolidation of the Songshan Formation due to the drawdown of groundwater in the Jingmei Formation reduced the movements of diaphragm wall toes.

In an interesting paper Yang et al studied the hydraulic characteristics of the Jingmei Formation and the Dewatering of Deep Excavations in Taipei Basin. Geotechnical Engineers in Taipei are well aware that the Jingmei Formation is a unique geological feature of the Taipei Basin. It is highly permeable and a water-rich stratum responsible for many failures in underground constructions. The piezometric heads in the Jingmei Formation had to be lowered by pumping for the deep excavations to be carried out safely. The authors thus discuss the hydraulic characteristics of the Jingmei Formation and the experience gained in large scale dewatering schemes. Attempts have been made to establish the relationship between the progression of tides in the river and the fluctuation of the piezometric levels in this Formation. The authors found that, the transmissivity and storage coefficient deduced from the observed groundwater drawdown are affected not only by the pumping rate, but also the duration of pumping; thus the rates required tend to be overestimated as based on the results of pumping tests.

Forensic studies have now become an important field in geotechnical engineering. The seventh paper by Lee et al is on the forensic investigation of a subway tunnel failure during construction. In this paper, the forensic evidences and investigation of a subway tunnel construction failure occurred in Kaohsiung, Taiwan is presented. The studied construction failure occurred during a cross-passage excavation of a shield tunnel construction work of the Kaohsiung Mass Rapid Transit System, and resulted in severe tunnel collapse and extensive ground failure that even reached to ground surface 30m above the tunnel depth. Valuable photo images obtained during and post event, as well as results of special geophysical testing methods were presented and compared to verify aspects of the proposed failure scenario. Information presented in this paper would be helpful to improve engineers' knowledge for preventing similar construction risks.

Typhoon Morakot brought tremendous rainfall of a hundred-year recurrence period in Taiwan. The paper by Chou et al concentrates on the effects as encountered by roads and houses in the middle and southern part of Taiwan; from landslides, debris flows, and floods. Erosion of road foundations, sliding of slopes, and collapse of bridges has paralysed the road system. Using Alishan Route 18 as an example, this paper discusses different causes, types, and renovation methods of slope disasters for future reference.

The paper by Lee et al also deals with the forecast of shallow landslides pertinent to Taiwan in a study which combines rainfall parameters and landslide susceptibility. Catastrophic landslides and debris slides triggered by typhoons such as Typhoon Morakot (2009) have occurred more frequently in the recent years, and caused many casualties and much economic loss in Taiwan. For the purpose of reducing the damage and preventing loss of life resulting from geological hazards, this study collects multiple period landslide inventories which contain the information of occurrence time, location, magnitude, rainfall intensity, and

accumulated rainfall to establish the rainfall threshold for shallow landslides on a regional scale. The concept of a hazard matrix which combines the magnitude (landslide ratio of slope units) and the possibility of occurrence (historical disaster records) are investigated to set up the early warning thresholds. Accordingly, the critical rainfall thresholds were built up based on the R_{24} (24 hours cumulated rainfall) and I_3 (3-hour mean rainfall intensity) of historical records. The model developed can predict the possible sediment hazard on the hillslope 2~9 hours before occurrence of landslides. The web based GIS helped to have early-warning systems to display the real-time rainfall data and the warning signal immediately for disaster prevention through increasing the response time.

Chang et al made dynamic analyses for performance based seismic design of geotechnical structures with examples in deep foundation. Performance-Based Seismic design (PBSD) of geotechnical engineering structures can be evaluated by a number of methods taking into account the uncertainties of the designed influence factors. Despite the fact that the seismic force is known to be a significant factor, the static and/or pseudo static analyses seem to be commonly adopted in design practice. The paper by Chang et al briefly discusses alternate approaches with the emphasis on dynamic analysis. Examples are given with the assessments of two deep foundations located in Taiwan. Dynamic analysis is rather important to the seismic design problems since it can monitor the details of time-dependent structural responses incorporating both peak ground acceleration and duration of the earthquake. Other than the 3D finite element analysis, the simplified solution from 1D wave equation analysis can be very effective and convenient for PBSD analysis on deep foundation.

The eleventh paper in this CTGS Issue is on the time dependent dynamic characteristics during soil liquefaction in saturated sand. Chen et al, conducted model pile tests to quantify the relation between soil stiffness and excess pore water pressure during liquefaction, the test data of a series of shaking table tests on model pile in saturated sand using a large biaxial laminar shear box conducted at the National Center for Research on Earthquake Engineering were analysed. The pile tip was fixed at the bottom of the shear box to simulate the condition of a pile foundation embedded in a firm stratum. The pile head was mounted with steel disks to simulate the superstructure. In addition, strain gauges and mini-accelerometers were placed on the pile surface to obtain the response of the pile under shaking. Therefore, the model pile can be considered as a sensor to evaluate the changes of dynamic characteristics of soil-pile system during the shaking by using the time-frequency analysis and system identification technique. The results showed that the stiffness of the soil would increase with the dissipation of pore water pressure and the recovery of soil stiffness is directly related to the effective stress ratio of soil specimen.

The interesting paper by Shi et al present geological investigation and sliding mitigation in Jiufen Area in Taiwan. Jiufen's orographic and geological characteristics together with frequent typhoons and heavy rain make it potentially vulnerable to landslides. The landslide problems can be disastrous not only to the 2,300 local residents, but also to the constant flow of tourists visiting the town. After the site investigations, it is concluded that both of the colluvium and groundwater are the most important

geological factors to the slope stability problems. According to the long-term groundwater level monitoring result, it varied from 8m to 12m during the period of typhoon and heavy rainfall. And the displacement induced by the groundwater level rising was found. Four underground flow lines were located based on the resistivity image profiling and self-potential investigation. Then five water collection wells were planned to construct according to the locations of underground flow lines. The level lowered down about 15m after the wells completed and the slope became stable. It is suggested that the depth of colluvium in Jiufen area needs to be investigated in more detail.

Finally the last paper thirteenth in this Issue is by Shu et al on the interpretation and analysis of potential fluidised landslide slope. Fluidized landslide, also called hillslope-type debris flow, often occurs on the village side hillslope in the mountain area during extreme weather condition. Fluidized landslide induces more severe damages than the shallow landslide; however its recognition model is still lacked. In this research a recognition model of the potential fluidized landslide slope was developed using 80 cases occurred in the Kaoping River basin, southern Taiwan. 30 fluidized landslides and 30 shallow landslides are employed for the model development and another 10 events of each landslide are applied for verification. Results show that the recognition model composed of 8 discriminant factors including geomorphology factors, hydrology factors and potential landslide factor predicated by SHALSTAB model provides accuracy rate of 85% of the verification events. Thus the model can be of practical use for fluidized landslide interpretation. The model can be used to identify the potential dangerous slope areas and effectively assist the disaster prevention and early warning of villages in mountain area.

The editor of this CTGS Issue is very pleased to be able to present the geotechnical activities in Taiwan through these thirteen contributions and hope that the material would be beneficial to Geotechnical Engineers in SE Asia and elsewhere.

Meei Ling Lin

ACKNOWLEDGEMENT

Thirteen excellent contributions are contained in this Country Issue of the Chinese Taipei Geotechnical Society (CTGS) as edited by Prof. Meei Ling Lin. All contributions are by authors from Taiwan and Prof. Meei Ling Lin must be congratulated for her excellent task. In the Preface Prof Lin have described in great detail the contributions from the authors. It is a pleasure to note that successful country issues are now completed by the Thai Geotechnical Society, The Vietnamese Society and now the Chinese Taipei Society. The contributions from Singapore, Hong Kong and Malaysia will also be released soon. Also, last but not least from Indonesia.

This issue also contains a special feature story on “Recent Diaphragm Wall Technologies and Future Challenges” by Hosoi Takeshi and Matsushita Shinya; a historical note on “Experiences of Geotechnical Development in Japan and Future Directions” by Masami Fukuoka and an “Obituary of Masami Fukuoka” by Fumio Tatsuoka. The passing away of Prof Masami Fukuoka on 27 January 2016 is a great loss to the engineering communities.

K. Y. Yong

N . Phienwej

T. A. Ooi

A. S. Balasubramaniam

GEOTECHNICAL ENGINEERING

JUNE 2016 ISSUE: CTGS ISSUE

Edited by Meei-Ling Lin



Professor Meei-Ling Lin

Dr. Lin is a Professor at Department of Civil Engineering, National Taiwan University. She received her Ph.D. degree in Civil Engineering from University of Texas, Austin, USA, in 1987. Dr. Lin has been a member of the General Committee of the Southeast Asia Geotechnical Society since 2007. She serves as a committee member of the Jointed Technical Committee 1 (JTC1 on Landslide) of the International Society for Soil Mechanics and Geotechnical Engineering, the International Association for Engineering Geology and the Environment, the International Society for Rock Mechanics, and the International Geotextile Society. She also serves as a committee member of Technical Committee 303 (TC-303 on Flood) and Asian Technical Committee-1 (ATC-1 on Climate Change) of ISSMGE.

Prof. Lin's research interests and experiences include: potential analysis and simulation and behaviors of debris flow and slope stability, seismic slope behavior and stability, dynamic soil behaviors associated with soil liquefaction and ground responses analysis, mapping and micro-zonation of related debris flow, seismic slope stability potential, and seismic ground response. She lead a group to initiate a drafted Code for the Engineered Slope for the Ministry of Transportation and Communication, Executive Yuan, Taiwan. She has been invited as a Keynote speaker of international conferences, a special lecture speaker of International Landslide Symposiums and a panel reporter by ISSMG Conferences, and recently delivered an Opening Keynote for the Fourth Italian Workshop on Landslides.

SPECIAL FEATURE STORY ON
“Recent Diaphragm Wall Technologies and Future Challenges”
By Hosoi Takeshi and Matsushita Shinya.



Dr. Hosoi Takeshi

Dr. Hosoi Takeshi is a Technical Advisor at WSP Parsons Brinckerhoff, Singapore. He received his PhD with research focused on “Bearing Capacity of Diaphragm Wall Foundation and various Issues during its Construction” from Kyoto University, Kyoto, Japan in the year 1993.

Dr. Hosoi has more than 50 years of experience in design and construction of underground structures, tunnelling, bridge foundations and marine works. He is an international expert in diaphragm wall, barrette and bored pile foundation, shield tunnelling, NATM tunnelling, and other complex geotechnical works.

He is a Professional Engineer (PE) in Japan Since 1983, Fellowship of Japanese Society of Civil Engineer and International Member of Japanese Geotechnical Society. He coordinated the Asian Ocean Seminar sponsored by Japanese Ministry of Port and Harbour for 10 years. He was also a national member in “E-Defence Project” in Japan.

He served as a General Manager of Technical Research & Earthquake Technology Research Institute for 8 years and General Manager of Design Department of Nishimatsu Construction Co. Ltd. for 7 years.



Mr. Matsushita Shinya

Mr. Matsushita Shinya has been a Chief Engineer of Matsushita M&C Lab Co. Ltd. Since 2013. He was graduated from Nagoya University (Department of Science) in 1972 and joined Matsushita M&C Lab Co. Ltd. in 1972. He served as CEO of Matsushita M&C Lab. Co. Ltd. from 2003-2013. He is a Member of Japanese Geotechnical Society. He has been involved in a lot of big diaphragm wall projects in Japan for more than 40 years. In 1982 he was engaged in the experimental diaphragm wall construction for practical use of high DS polymer slurry and in 1984 he was joined the diaphragm wall construction project for Nagoya Subway 6 Line to lead successful adoption of polymer slurry. He was involved in Diaphragm Wall Foundation of Aomori Bay Bridge in 1988 and also in 1991 Diaphragm Wall Shaft at Kawasaki Artificial Island for Trans Tokyo Bay Highway Road. From 1992 to 1994 he was invited by the Grand Hi-Lai Hotel project and the Tuntex project (the Tuntex & Chien Tai Tower) at Kaohsiung, Taiwan as a consultant of Polymer slurry. From 2001 to 2006 he took part in the Water

Cut-off Wall Project at Kansai International Airport for stabilizing land settlement as a chief engineer for quality control of slurry. In 2008 he engaged in the Wall Foundation , “Knuckle Wall ” Project of Tokyo Sky Tree as a chief engineer for quality control of polymer slurry.

HISTORICAL NOTE ON

“Experiences of Geotechnical Development in Japan and Future Directions”

By Masami Fukuoka



Professor Masami Fukuoka

Prof. Fukuoka was born on 12 March 1917 in Okayama Prefecture, Japan. He studied Civil Engineering at the University of Tokyo, and in 1940 he entered the profession fully, taking up a post as a civil engineer for Japan's Public Works Research Institute (PWRI) of the Ministry of Internal Affairs. During the Second World War, he served in the Japanese military.

He returned to PWRI after the war ended, and his engineering acumen was immediately needed. Japan experienced a series of severe earthquakes and floods, which further complicated the damage the country had suffered to its infrastructure during the war. It was one of the most difficult times in the history of Japan, he said to me when I was young. As a civil engineer, in particular, as a geotechnical engineer, he worked to restore Japan's infrastructures from the effects of war and natural disasters. His strength of leadership was an especially important contribution to the design and construction of a great number of important infrastructures; and his work improved projects across a broad range of sectors, including those dealing landslides, road building and pavements, slope stability, flood control, river and coastal dyke engineering, ground investigation and soil test, earth pressure and retaining walls, rock-fill and earth-fill dams, ground subsidence, foundations of long-span bridges, earthquake geotechnical engineering and, eventually, geosynthetic engineering. The breadth of his work was extraordinary, considering how difficult it is to become a specialist in even one of these areas today. After rising to serve as PWRI's director, he retired in 1970 and entered academia and became a full professor of Civil Engineering of the University of Tokyo, where I was studying as doctoral candidate. In 1977, Prof. Fukuoka transitioned to a

professorship at Tokyo University of Science where he remained until his retirement in 1986. As his career progressed; he contributed greatly to multiple professional organizations. He helped establish the Japanese Geotechnical Society (JGS) in 1949 and served as President from 1976 – 1997. He was integral to Tokyo playing host to the 9th International Conference on Soil Mechanics and Foundation Engineering, then served as President of the International Society for Soil Mechanics and Foundation Engineering (now ISSMGE) from 1977-1981. During this period, while at Tokyo University of Science, he started the research on geosynthetic-reinforced soil retaining walls and geomembrane lining at the bottom of reservoirs.

GEOTECHNICAL ENGINEERING

June 2016: CHINESE TAIPEI SPECIAL ISSUE

Editor: Professor Meei-Ling Lin

TABLE OF CONTENTS

<u>List of Papers</u>	<u>Page</u>
1: Rock Tunneling Applied to Steady Water Resources Supply in Taiwan: Challenges and Examples By Chia-Han Lee, Tai-Tien Wang, Shih-Hsien Chang, Shang-Yao Lien and Shih-Wei Huang	01-06
2: State-of-the Art of the Tunnel Maintenance in Taiwan and Challenges to Sustainable Development By Ya-Chu Chiu, Tai-Tien Wang, Tsan-Hwei Huang	07-13
3: Tunneling Issues Regarding the Rock Tunnel-Shaft Intersection in Taiwan By Tai-Tien. Wang, Tzu-Tung. Lee, Shun-Min. Lee, Kwei-Shr. Li and Cheng-Hsun. Chen	14-23
4: Assessment of Hard Rock Tunnel Stability: A Note on the Influence of Post-peak Strength Degradation By F. Y. Hsiao, H. C. Kao and S. Y. Chi	24-31
5: Deep Excavations in Taipei Basin and Performance of Diaphragm Walls By R. N. Hwang, C. H. Wang, C. R. Chou and L. W. Wong	32-40
6: Hydraulic Characteristics of Jingmei Formation and Dewatering for Deep Excavations in Taipei Basin By G. R. Yang, L. W. Wong and R. N. Hwang	41-49
7: Forensic Investigation of A Subway Tunnel Construction Failure By W. F. Lee, C. C. Wang, K. Ishihara, R. N. Hwang	50-59
8: Case Study of Renovation on Alishan Route 18 after Typhoon Morakot By Kung-Tai Chou, Wen-Long Wu, Chiao-An Hsiao, Kun-Hsien Chou	60-71
9: Combining rainfall parameter and landslide susceptibility to forecast shallow landslide in Taiwan By C.F. Lee, C.M. Huang, T.C. Tsao, L.W. Wei, W.K. Huang, C.T. Cheng, and C.C. Chi	72-82
10: Dynamic Analyses for Performance-Based Seismic Design of Geotechnical Structures with Examples in Deep Foundations By D.W. Chang, C.W. Lu, S.S. Lin and J.R. Lai	83-88
11: Time-Dependent Dynamic Characteristics of Model Pile in Saturated Sand during Soil Liquefaction By Chia-Han Chen, Yung-Yen Ko, Cheng-Hsing Chen and Tzou-Shin Ueng	89-94
12: Geological Investigation and Sliding Mitigation in Jiufen Area By Lee-Ping Shi, Jen-Cheng Liao, Sheng-Hsiung Hung and Chien-Shui Huang	95-100

13: Interpretation and Analysis of Potential Fluidized Landslide Slope	101-111
By H. M. Shu, T. C. Chen, W.C. Yang and Y.X. Luo	
<i>SPECIAL FEATURE STORY ON “Recent Diaphragm Wall Technologies and Future Challenge”</i>	112-125
By Hosoi Takeshi and Matsushita Shinya	
<i>HISTORICAL NOTE ON “Experiences of Geotechnical Development in Japan and Future Directions”</i>	126-129
By Masami Fukuoka	
<i>OBITUARY of Masami Fukuoka</i>	130-131
By Fumio Tatsuoka	

Cover Photographs:

1. Photo 1 Satellite Image of the Taipei Basin (After Yang, Wong and Hwang, June 2016)
2. Photo 1 Sedimentation of Typhoon Morakot on Wanda Reservoir in central Taiwan. (After Lee, Wang, Chang Lien and Huang, June 2016)
3. Photo 1 Geological profile along tunnels in TDT project (After Lee, Wang, Chang, Lien and Huang, 2016)

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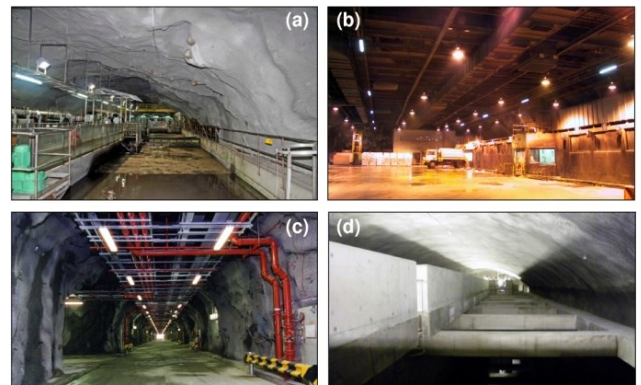


Editor: Sing Lok Chiu (Hong Kong Part) and Tiong Guan Ng (Singapore Part) & San Shyan Lin (Contributed Papers)



1972 Po Shan landslide in Hong Kong

(After Ho and Cheung 2016)



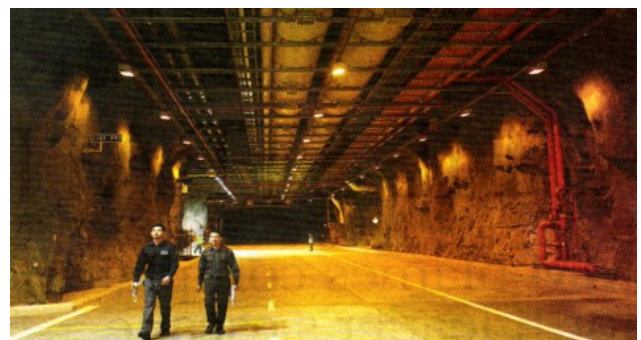
Examples of purpose-built caverns in Hong Kong

(After Ng et al) 2016)



Layout plan of DTL3 alignment and location of C922

ORT in Singapore (After Ng and Low 2016)



Underground Ammunition Facility cavern in Singapore

(After Zhou and Zhao, 2016)

GEOTECHNICAL ENGINEERING

PREFACE

This is a combined Issue of paper contributions from Hong Kong and Singapore; it contains eighteen excellent papers including four papers directly submitted to the SEAGS Secretariat.

The first paper by Ho & Cheung is on challenges in improving slope safety through the landslip prevention and mitigation program. In 1977, the Hong Kong Government embarked on a systematic retrofitting programme, known as the Landslip Preventive Measures (LPM) Programme, to systematically upgrade existing substandard man-made slopes to meet modern safety standards. By 2010, some 4,500 high-risk government man-made slopes have been upgraded through engineering works, and the overall landslide risk arising from man-made slopes has been reduced to less than 25% of the 1977 level. Over the years, the programme has evolved progressively in response to Government's continuous improvement initiatives and rising public expectations in respect of slope safety and slope appearance. In 2010, the Government launched the Landslip Prevention and Mitigation (LPMit) Programme to dovetail with the LPM Programme, with the focus being on retrofitting the remaining moderate-risk substandard man-made slopes and systematically mitigating natural terrain landslide risk. This paper presents the challenges, technical advances and achievements of the LPM and LPMit Programmes.

The second paper is by Ng et al on Rock caverns- Hong Kong's hidden land. The hilly terrain and underlying geology of Hong Kong offer an excellent opportunity for placing urban facilities underground. About two-thirds of Hong Kong's land is found to be suitable for rock cavern development. Given the potential for multi-layer cavern development, a substantial usable area could be created. In September 2012, the Civil Engineering and Development Department of the Government of the Hong Kong Special Administrative Region commenced a study on "Long-term Strategy for Cavern Development", to develop a holistic approach in planning and implementing cavern development and render it a sustainable means for expanding land resources. The study also places emphasis on private sector participation as facilities, such as storage, warehousing and data centres, can benefit from rock caverns' stable and secure setting. Implementation of a long-term strategy for cavern development could provide a sustainable approach in easing the pressure of land shortage. Developing a systematic relocation programme for suitable Government facilities could release surface sites for other uses including housing, and placing nuisance or potentially hazardous facilities in caverns could remove incompatible land uses. Reserving rock cavern space to accommodate future public and private sector facilities underground could further reduce the land take. The Hong Kong Government has also commenced an initiative to explore the potential of underground space development in the urban areas. Facilitating rock cavern development at the urban fringes and underground space development in the urban areas could enhance Hong Kong's utilisation of land resources in pursuit of sustainable development.

The third paper is on the first subsea TBM road tunnel in Hong Kong by Liu et al. Subsea tunnels for transportation are traditionally constructed in the form of Immersed Tunnel (IMT). With the technical advancement of mechanized Tunnel Boring Machine (TBM) construction, subsea TBM bored tunnels were successfully constructed in different parts of the World over the last decade. Using a TBM has benefits over the IMT when excavating beneath the sea, since it does not require dredging and marine access. This makes it particularly favourable when coping with environmental concerns and constraints within existing shipping passages. Since the first subsea tunnel across the Victoria Harbour in Hong Kong was constructed in 1972 by immersed tunnel method, four other additional subsea immersed tunnels were constructed across the same Victoria Harbour between 1979 and 1997. The subsea tunnel of Tuen Mun – Chek Lap Kok Link (TM-CLKL) was also originally proposed using immersed tunnel method in the feasibility study stage. However, the tunnel scheme was changed to TBM bored tunnel in the Investigation and Preliminary Design Stage. The TBM bored tunnel scheme was further developed in the Detailed Design Stage and the project is now under construction. This would be the first subsea TBM road tunnel in Hong Kong and this paper discusses the key considerations and rationales in changing the original IMT scheme to the TBM bored tunnel scheme for the subsea tunnel section of TM-CLKL.

The fourth paper is by Tam and Chang on achievements and challenges to the Hong Kong landslide risk management. Landslide is one of the common natural hazards in Hong Kong. With the Government and public's concerted efforts, landslide risk in Hong Kong has been drastically reduced since the establishment of a comprehensive slope safety system in 1977. However, given Hong Kong's climatic and geographical conditions and the current state of technology, occurrence of serious landslides that could potentially cause multiple fatalities remains a distinct possibility, particularly during extreme rainfall events.

The fifth paper by Tsang et al is on sub sea horizontal directions coring (HDC). The Tuen Mun – Chek Lap Kok Link comprises a 9 km long dual 2-lane carriageway between Tuen Mun and North Lantau, with approximately 5 km long sub-sea tunnel between Hong Kong Boundary Crossing Facilities and Tuen Mun. This is a major highway infrastructure constructed to alleviate the increase in cross boundary traffic due to projected developments in the Northwest New Territories and North Lantau in Hong Kong, including the Airport developments and the Hong Kong-Zhuhai-Macao Bridge. The proposed subsea tunnel is to be constructed by large diameter Tunnel Boring Machines (TBM) which will bore underneath two sets of existing submarine power cables providing power supply to the Hong Kong International Airport. Ground investigation using conventional vertical marine drill holes is not allowed within the cable protection zone with the considerations of the potential risk of damaging the power cables. To provide sufficient ground information for the design of the proposed TBM tunnel, Horizontal Directional Coring (HDC) with a total length of 660m was proposed at the invert level along the tunnel alignment. It was anticipated that the HDC would go through rock, soil or soil/rock interface and terminate at interface of soft / mixed ground. The HDC works has been completed in mid-2013. This paper describes the design considerations and the trajectory planning of the HDC work, with construction of a marine platform (of size 15m x 20m to facilitate the installation of the HDC). The difficulties and problems encountered during the subsea horizontal drilling is also discussed.

The sixth paper from Hong Kong contribution is the seventh Lumb lecture by Endicott. The Lumb Lecture is held in Hong Kong biennially to celebrate the work and the legacy of a great Geotechnical Engineer, Professor Peter Lumb. This paper reviews changes in geotechnical practice, in and around Hong Kong, since his retirement and shows remarkable developments and some folly. What would he think of his legacy? Would he be disillusioned by folly or would he have taken satisfaction to see that, in many instances, his legacy lives on. There are a number of valid successors following in Peter's footsteps. This paper has drawn extensively upon the work of many good geotechnical engineers and is dedicated as a tribute to all of the geotechnical engineers, engineering geologists, geologists and other people who have made the name of Hong Kong synonymous with ground engineering. There are too many to single out individually.

The second part of this Issue is contributions from Singapore. The papers are numbered continuously. Thus the seventh paper is by Ng and Low on Singapore case histories for the circle line and down town line projects. The case history of Overrun Tunnel (ORT) of C922 is basically an underground facility building functions as both Railway Facility (Operation Control Centre) and Electrical Substation (ESS) which is to be built next the Expo Station. ORT is located in old alluvium (OA). The proposed underground overrun tunnel is a box structure with dimensions of approximately 23m wide, 25m deep and approximately 440m long. The proposed diaphragm wall function as the earth retaining system (ERSS), it designed for both temporary loading conditions during excavation and permanent load conditions in accordance with LTA Civil Design Criteria. Bottom-up construction sequence is adopted where lateral supports using four (S3 to S6) or six (S1 to S6) layers of steel strutting were installed as excavation progresses downward. The most challenging part is the omission of the last layer of strut S6 for the whole ORT by using observational approach. The case history of C824 Nicoll Highway Station demonstrates that Jet Mechanical Mixing (JMM), if properly installed, has major benefits in controlling the stability and movements induced by deep excavations in soft ground. The reasons can be attributed to the fact that the inner soil column is comprehensively mixed, combined with the attributes of the outer jet grouted column with sufficient overlapping. The whole process undergoes tight quality control and rigorous testing to ensure a continuous and comprehensive slab. In addition to the JMM slab, there is the major benefit of the discrete soil mixing columns formed above the JMM slab during the withdrawal of the auger.

The eighth paper is on an update of the vacuum preloading methods by Chu et al. It has been more than 60 years since the concept of vacuum preloading was proposed. The vacuum preloading method has been evolving. There have been considerable improvements in the techniques as well as new applications. In this paper, several vacuum preloading methods including some new variations are introduced. The advantages and disadvantages of each method are compared. Technical issues such as improvement depth, vacuum pressure distribution in soil, and evaluation of degree of consolidation for soil under vacuum consolidation are discussed. A case history using a combined vacuum and fill surcharge preloading method for soft soil improvement is also used to illustrate the changes in the pore pressure versus depth profiles and the application of the method to calculate degree of consolidation using pore water pressure distributions.

In the ninth paper a new lithostratigraphical framework is proposed for Singapore by Lat et al. A study was initiated in mid-2013 by Building & Construction Authority of Singapore (BCA) to review the existing stratigraphy framework of Singapore. The new lithostratigraphical framework follows the recommendations of International Commission of Stratigraphy (ICS) and it was developed based on geological fieldworks observations and rock cores examination obtained from new deep boreholes. This paper will only cover on the Jurong Formation, Fort Canning Boulder Bed and Old Alluvium. The Jurong Formation has been upgraded to Jurong group according to ICS stratigraphy guidelines and the Jurong group is sub-divided into three (3) formations, known as Tuas formation, Bukit Resam formation and Pasir Panjang formation. The Fort Canning Boulder Bed and Old Alluvium have been re-classified as Fort Canning formation and Bedok formation respectively.

The following paper tenth in the series is by Tan on economical design of non-negative skin friction piles in soft clays. Code based design of piles with NSF consider the NSF force as a dragload to be imposed on the pile as an unfavourable design action. These codes like Singapore CP4, UK BS 8004 and the recent EC7 would indirectly factor up the value of the dragload while at the same time factor down the positive shaft friction below the neutral plane. Thus the pile design in very deep soft clays typical of Singapore and Asean coastal plains will lead to very conservative pile lengths to meet the code requirements. The Unified pile design method of Fellenius recognized this deficiency and it allows for better pile design with NSF taking into account the need for both force and settlement equilibrium between pile and soil. Fortunately, EC7 also allows for interactive pile/soil analysis using modern FEM tools that can optimise pile design for NSF, particularly when the remaining consolidation settlements around the piles are relatively small. This paper will compare these methods and provide insights into the proper understanding of NSF effects on pile behaviour, and recommend the way forward for rational and economical pile design in settling soils.

The eleventh paper is by Liu et al on design framework for spatial variability in cement treatment for underground construction. The most common form of ground treatment used to facilitate underground construction in Singapore is cement treatment. However, there is currently no indication on how safe and how conservative this adopted strength is since the prescribed strength bears no relationship to the probability of failure or factor of safety. This paper examined several sources leading to non-uniformity and spatial variation in cement-treated soils, including curing time effect, influence of operating parameters on slurry concentration, in-situ water content and column positioning errors. A framework for design and monitoring of ground treatment by cement was proposed.

The twelfth paper by Zhou and Zhao is on advances and challenges in underground space utility in Singapore. Despite its promise and many benefits for sustainable urban development, the use of underground space has tended to be the last resort, due to high development cost and the complexities in the planning and development of underground space. In 2010, the Economic Strategies Committee of the Singapore government made developing underground space part of the government's long-term economic strategy with specific recommendations on master planning, geological investigations, investment in research and development, and various policy issues. With this, the use of underground space has been

elevated to a strategic level and has become an economic imperative in land-scarce Singapore. The ESC report also recommended that the government should take the lead in catalysing the use of underground space. Based on these recommendations, the Singapore government has taken various initiatives and studies, and initiated various research projects in support of these initiatives. This top-down strategy has also made it possible to plan and coordinate the development of underground space in a holistic manner, and helps overcome of the key challenges at the systems. This paper gives a review of advances in underground space development, highlights some key challenges, and discusses the various recent studies and planning issues, and examines possible strategies for future use of underground space in Singapore. Furthermore, another four papers are included as contributed directly to the Editorial Team in this issue.

The thirteenth paper by Shaia and Abuel-Naga investigated the ageing induced changes in Fiber-Reinforced Polymer (FRP)/Granular interface shear behaviour under different aging environments. The test results indicated that FRP-granular interface shear behaviour was improved after subjected to the adopted aging environments. This improvement in the FRP interface shear behaviour could be mainly attributed to the observed increase in surface roughness under aging process.

The fourteenth paper authored by Dassanayake, Phien-wej and Giao dealt with modeling the groundwater pressure effect and slope stability analysis of C1 pit on deep pit mining of Mae Moh open pit lignite mine, Thailand. Stability of the west wall of the C1 pit for 2017 pit slope was evaluated in terms of the safety factor by the limit equilibrium method. Results obtained in this study indicated that the west wall is susceptible to failure due to water pressure associated with it. To maintain a safe slope, potentiometric head within west wall of C1 pit should be maintained below 170m, MSL.

In the fifteenth paper, Chen, Lin, Lee and Chen developed a seepage flow direct shear test device to investigate the effects of internal erosion to non-plastic silty sand prior to shearing. Tested results revealed that fines contents had noticeable influence on soil behaviours, regardless of whether an internal erosion process was applied to the samples.

In the sixteenth paper the Influencing factors including the Poisson's ratio and the rock specimen thickness on Brazilian test results are investigated by Yang and Wang using PFC3D program based on a complex-shaped grain model which can capture all the characteristics of brittle rock in three-dimensional environment. Through investigating the stress-strain curves and crack developing processes of the Brazilian test specimens, it was concluded that the Brazilian tensile strength will increase with the specimen thickness due to the great loading increment.

In the seventeenth paper an attempt was made by Cheng, Chern, Wu, and Lin to investigate the shear behaviour of soft rock joints under Constant Normal Load conditions, with special reference to the influences of infill thickness and moisture content on shear behavior of planar and rough joints. The results of this study showed that infilled water content could influence shear strength of planar and rough rock joints, more significant than infill thickness.

The last paper, by T.G.Santhoshkumar, Benny Mathews Abraham, A, Sridharan, and Babu T Jose, investigated the effectiveness of bentonite in improving the lateral flow of cement grouts in a coarse sand. It was found in the paper that addition of small percentages of bentonite and detergent increases the lateral flow of cement grout in coarse sand. The results indicated that addition of even a small amount of bentonite to the cement grout increases the grouting efficiency in coarse sand.

This combined Issue of the papers from Hong Kong, Singapore and other submissions makes further contributions in the development of Geotechnical Engineering in SE Asia. The editors are very pleased to have the opportunity in compiling the material presented herein.

**Sing Lok Chiu (Hong Kong Part),
Tiong Guan Ng (Singapore Part)
San Shyan Lin (Contributed Papers)**

ACKNOWLEDGEMENT

Eighteen paper contributions contained in this issue are from Hong Kong, Singapore and papers contributed directly to the Editorial Team. No doubt the material contained therein would be most valuable to our engineering 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

Noppodol Phienwej

Prof. A. S. Balasubramaniam

GEOTECHNICAL ENGINEERING

September 2016: HONG KONG AND SINGAPORE SPECIAL ISSUE

Edited by

Sing Lok Chiu (*Part A: Hong Kong*), **Tiong Guan Ng** (*Part B: Singapore*) and
Prof. San-Shyan Lin (*Part C: Contributed Papers*)



Dr. Sing Lok Chiu
(*Hong Kong Part*)

Dr. SL Chiu, a registered geotechnical engineer to the Buildings Department of the government of the Hong Kong SAR, a geotechnical specialist. He graduated from Civil engineering department of National Taiwan University, MSc and DIC in “Soil Mechanics” at Imperial College of London University, UK, and PhD in “soil behaviours Mechanics” at Imperial College of London University, UK, and PhD in “soil behaviours at elevated temperature” at University of Sydney, Australia. He is a technical director (geotechnical) with AECOM Asia Company Limited, has been practising in geotechnical engineering field for more than 30 years. He has been DPM, PM, and special task team leader of various Landslip preventive Measures (LPM) Agreements with Geotechnical Engineering Office (GEO) of HKSAR Government as well as natural terrain hazard study agreements with Hong Kong Housing Authority (HKHA) over the past 15 years.

Besides, he has been actively involved in design and construction supervision of numerous prestigious site formation, foundation and deep basement construction works in urban areas, reclamations and ground improvement works in Hong Kong as well as throughout SE Asia and China. He recently led a team of foundation and bridge engineers undertaking design of the 2nd Penang Bridge – a cable-stayed bridge of total length of 26 km in Malaysia. At present, he is leading a team of geotechnical engineers undertaking tender design of KVMRT Line 2.



Dr. Tiong Guan Ng
(Singapore Part)

Dr. TG Ng is the immediate Past President of Geotechnical Society of Singapore (2014-2015). He graduated from the University Technology Malaysia (UTM) with first class honours degree in Bachelor of Civil Engineering in 1992. He obtained his PhD degree in the research of Spud Can Foundation on Sand in 1999 from the National University of Singapore (NUS). He left NUS to join a specialist ground engineering company as design engineer in 2000. In Feb 2002, he co-founded GeoEng Consultants, a consultancy firm specializing in civil and geotechnical works, which grows to become one of the largest geotechnical consultancy firms in Singapore in a few years. In Nov 2011 GeoEng Consultants was acquired and became part of Golder Associates, a global consultancy company specialists in ground engineering and environmental services.

At present, Dr. Ng is the Principal and Executive Director of Golder Associates in Singapore leading the local Geotechnical Business Unit. He specialises in analysis and design of earth retaining system, and has special interest in back-analysis and interpretation of instrumentation. He had involved in the design and supervision of earth retaining structures for several major projects in Singapore which include the world 1st underground MRT Depot (LTA Circle Line Contract 821), Geylang River Cross for Kallang Paya Lebar Expressway (LTA Contract 421), the deepest excavation within Marina Bay Sands Integrated Resort for MRT tunnels below Bayfront Avenue and Construction of Downtown Line 1 Promenade Station (LTA Contract 902). He also involved in the assessment and review of several geotechnical failure cases in Singapore which include excavation failure at Lengkong Empat, foundation failure at Church Street, the collapse of excavation at Nichol Highway Station and water leakage at Jalan Besar Station. He is currently leading the team for design and supervision of Changi Land Preparation Project.



Prof. San-Shyan Lin
(Contributed Papers)

Dr. Lin is a Professor at Department of Harbor and River Engineering of National Taiwan Ocean University in Taiwan. He received his Ph.D. degree in Civil Engineering from Washington University in St. Louis, Missouri USA in 1992. Dr. Lin was an engineer at Taiwan Area National Expressway Engineering Bureau from 1992 to 1994. Prof. Lin also served as TRB A2K03 Committee member on Foundations of Bridges and Other Structures between 1995 and 2004. He is also serving as committee member of TC-212 and ATC-1 of ISSMGE and as editorial board member of four major international journals in geotechnical engineering.

Prof. Lin's research and practical experiences have been dealt with static and dynamic behaviour of deep foundations, ground improvement and effects of scouring on bridge foundations. In the past decades, he was involved in many research projects such as interpretation of pile load testing results due to axial, lateral, or combined loading; effect of soil liquefaction on performance of pile foundation in sand; seismic effect of pile foundations; performance of suction pile in sand or in clay; and effect of scouring on performance of pile and caisson foundations etc. Prof. Lin has published more than 110 peer-reviewed journal papers and conference papers. One of his published Journal papers dealing with cyclic lateral loading effect on permanent strain of deep foundation due to cyclic lateral loading has been cited more than 66 times in Google academic website by many international researchers working on wind turbine foundations.

GEOTECHNICAL ENGINEERING

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TABLE OF CONTENTS

<u>List of Papers</u>	<u>Page</u>
PART A - HONG KONG	
1: Challenges in Improving Slope Safety in Hong Kong through the Landslip Prevention and Mitigation Programme By Ken K.S. Ho and Raymond W.M. Cheung	01- 10
2: Rock Caverns – Hong Kong’s Hidden Land By K.C. Ng, K.J. Roberts and Y.K. Ho	11-18
3: The First Subsea TBM Road Tunnel in Hong Kong By Albert Liu, Stephen Chan, Conrad Ng, Joseph Lo, C. K. Tsang and Dunson Shut	19-24
4: Achievements of and Challenges to the Hong Kong Landslide Risk Management By Rick CK Tam and Michael MK Chang	25-30
5: Subsea Horizontal Directional Coring (HDC) By C. K. Tsang, S. F. Chau and Jimmy Chan	31-36
6: 7 th Lumb lecture 10th October 2012 “Peter Lumb’s legacy, Soil Mechanics = Simple concepts + mathematical processes + lateral thinking” By John Endicott	37-50
PART B - SINGAPORE	
7: Singapore Case Histories on Omission of Strut by Observation Approach For Circle Line and Down Town Line Projects By David Ng C. C. and Simon Low Y. H.	51-61
8: Vacuum preloading methods: an update By Jian Chu, Shuwang Yan and Wei Guo	62-69
9: A New Lithostratigraphical Framework Proposed for Singapore	70-73

By K.K Lat, K.H Goay, S.G Lau, S.L Chiam and K.C Chew

- 10: Economical Design for NSF Piles in Soft Clays using Soil-Structure Interaction 74-78
By Siew Ann Tan
- 11: Towards a Design Framework for Spatial Variability in Cement Treatment for Underground Construction 79-84
By Y. Liu, Y. Jiang and F. H. Lee
- 12: Advances and Challenges in Underground Space Use in Singapore 85-95
By Y. Zhou and J. Zhao

PART C - Contributed Papers

- 13: Effect of Ageing Environment on Fiber-Reinforced Polymer/Granular Interface Shear Behaviour 96 -100
By H.A. Shaia and H.M. Abuel-Naga
- 14: Groundwater Flow Modeling and Slope Stability Analysis for Deepening of Mae Moh Open Pit Lignite Mine 101-115
By A.B.N. Dassanayake, N. Phien-wej and P. H. Giao
- 15: A Study on Internal Erosion of Low-Plasticity Silty Sand 116-122
By Jing-Wen Chen, Bo-Rung Lin, Wei F. Lee and Yie-Ruey Chen
- 16: Analysis of Influencing Factors on Brazilian Test Results Based on A Complex-shaped Grain Model for Brittle Rock 123-129
By Guangcheng Yang and Xinghua Wang
- 17: Effect of Infill Moisture Content and Thickness on Shear Behavior of Planar and Rough Rock Joints 130-135
By Tsu-Chiang Cheng, Shuh-Gi Chern, Shin-Ru Wu and Yu-The Lin
- 18: Role of Bentonite in Improving the Efficiency of Cement Grouting in Coarse Sand 136-143
By T.G.Santhoshkumar, Benny Mathews Abraham, A, Sridharan, and Babu T Jose

Cover Photographs:

1. 1972 Po Shan landslide in HK (After Ho and Cheung 2016)
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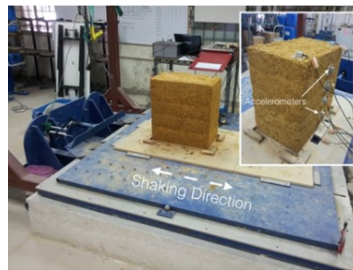
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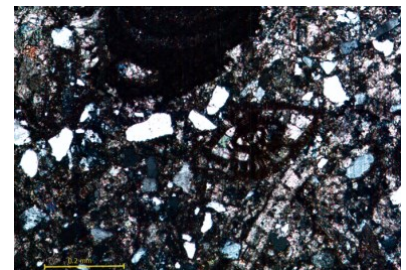
Thien Seng Yee, Swee Huat Chan and Teik Aun Ooi



Weathering profile of tropical residual soil (After Lee, et al, 2016)



Shaking table test on soil block (After Tanaka and Lee, 2016)



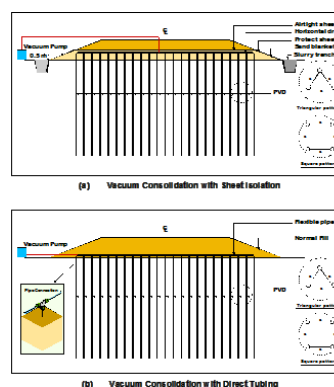
Petrographic thin section of hardpan calcrete (After Sim, et al, 2016)



Jeddah Tower, Saudi Arabia (After Poulos, 2016)



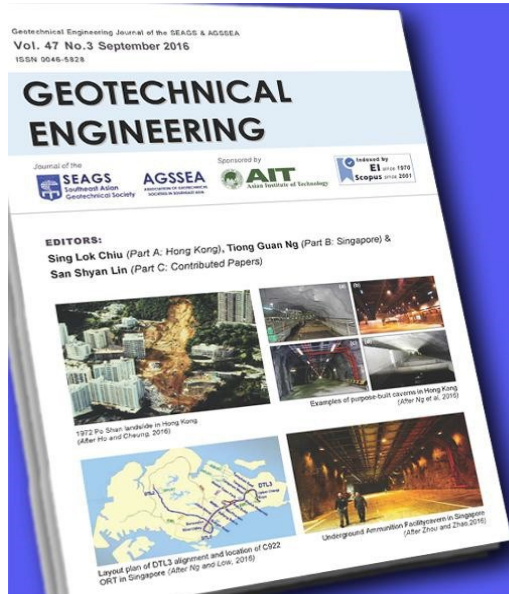
Burj Khalifa Tower, Dubai (After Poulos, 2016)



Vacuum Consolidation, Vietnam (After Seah et al, 2016)



Bird-eye view of pier platform (After Ishihara, 2016)



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YOU ARE KINDLY REQUESTED TO CONTRIBUTE ARTICLES IN FUTURE ISSUES AND ALSO HELP IN REVIEWING AS WELL.

PREFACE

The first paper is by Za Chieh Moh on Professionalism and ethics of geotechnical engineering. According to Moh, Ethics is the branch of philosophy that involves systematizing, defending, and recommending concepts of right and wrong conduct. Ethics is qualitative. It may change with time, circumstance and environment. Practice of ethics requires proper understanding of the time frame. Many professional engineering organizations have a set of Code of Ethics or Code of Practice to regulate or guide their members. Basically they all center around public welfare, sustainable development, professional competence, truthful and faithful, honourable, responsibly and lawfully. Success of engineering projects not only depends upon the engineering professional, but it also closely related to other non-engineering professionals. In the paper, discussions are presented about engineering ethics for non-engineering professionals. Ishihara in the Chin Fung Kee named lecture dealt with recent advances in pile testing and diaphragm wall constructions in Japan.

The second paper by Ishihara consists of brief introduction of the in-situ pile loading tests that have been conducted in Japan over the last two decades in connection with the design and construction of high-rise buildings in areas of soft soil deposits. In addition to the conventional types of tests in which the load is applied at the top and at the toe of the pile (O-cell test), what may be called “pile toe bearing test” and “skin friction test” is introduced. The results of these tests are described and compared with those from the conventional type of the pile loading tests. In-situ prototype tests are also introduced in which bearing power of Barrette type pile is compared with that of the circular type pile. A special case of in-situ pile loading tests conducted in Singapore is also introduced in which the friction between the circular ring-shaped concrete segment and the surrounding soil deposit was measured directly during excavation of the shaft by applying loads up and down by jacks installed between two adjacent segments in vertical direction. The latter part of this paper is a brief description on constructions of large-diameter circular diaphragm walls that was carried out about 10 years ago for the LNG storage tank in the coastal site in Tokyo Bay. The construction of the large-scale Kawasaki Island in the middle of Tokyo Bay in Japan will also be introduced. The whole scheme and process of construction for these two undertakings is introduced with some comments on observed behaviour of the walls and on special precaution taken during construction.

The third paper by Jian Chu dealt with innovations in soil improvement methods. These include the dynamic replacement and mixing method for the improvement of peaty soil, the layered clay-sand method for land reclamation using clayey fill, and the biodegradable fiberdrains. Other new soil improvement methods in the related areas are also presented to illustrate the role of innovation in the advance of soil improvement technologies. These include the drainage enhanced dynamic compaction method for the improvement of clay layers, the underwater dynamic replacement method for the treatment of seabed clayey soil, the use of the vacuum preloading with horizontal drains method, methods to form working platform on top of soft fill for land reclamation using soft fill materials, the NEUSpace method for land reclamation in deep water, and the new types of prefabricated vertical drains (PVDs). Methods for mitigation of liquefaction hazard, making water pond in sand, and prevention of dike failure from overtopping using biotechnologies are also introduced.

The fourth paper by Poulos dealt with lessons learned from designing high-rise building foundations. The design of tall building foundations involves a systematic process which incorporates ground investigation, ground characterization, preliminary design of the foundation system for the anticipated structural loads, detailed foundation design, load testing of the proposed foundations, modification of the foundation design, if appropriate, and monitoring of the foundation performance as construction proceeds.

This paper also described the process and some of the tools available for implementing it. It then set out a series of lessons learned during the design of such foundations, and illustrate these lessons with examples from projects in Asia and the Middle East.

The fifth Paper by Buddhima Indraratna and his co-authors is on the subject of the Advancements in Rail Track Geotechnology at Increased Speeds and Axle Loads . Ballasted railroads are designed to provide high speed commuter and heavy haul transportation. Ballast is one of most important load bearing components of the track substructure. However, it often experiences excessive settlement, lateral deformation and particle breakage when subjected to large dynamic (cyclic and impact) stresses. In addition, tracks constructed along coastal areas often undergo large settlements over soft compressible estuarine deposits, leading to frequent and costly track maintenance. The use of artificial inclusions such as geogrids, geocomposites, shock-mats (rubber) and prefabricated vertical drains (PVDs) are attractive options to maintain the vertical and horizontal alignment of tracks and to curtail excessive maintenance costs. This paper provides a deeper insight to the recent advancements in rail track geotechnology at increased in speeds and axle loads.

The sixth Paper by P.V. Long and his co-authors is on the subject of “Performance and Analyses of Thick Soft Clay Deposit Improved by PVD with Surcharge Preloading and Vacuum Consolidation – A Case Study at CMIT”. The authors discussed ground improvement using PVD for increasing foundation stability and controlling residual settlements of the container yard constructed on 35 m thick soft clay deposit at CMIT, Vietnam. The treated area is about 40 ha including vacuum consolidation combined with 6.3 m embankment surcharge for a strip of 57 m along the river bank (VCA) and conventional surcharge preloading using 9.1 m sand fill embankment for the remaining area. The monitored data indicated that PVD thickness of 3 mm arranged in spacing of 0.9 m to 1.2 m can be used successfully for improvement of thick soft clay deposit in both methods of embankment preloading with and without vacuum pumping. Performance of reduced embankment combined with vacuum pumping is very much better than that of conventional embankment preloading in terms of shortening construction time, reducing lateral displacement, increasing stability, and minimizing residual settlement. Back calculated c_h value is dependent on the assumptions of smear effects including smear zone ratio, d_s/d_m and permeability ratio, $R_s = k_h/k_s$. For $d_s/d_m = 2$ as commonly used, the back-calculated c_h value is directly proportional to R_s and the value of R_s in vacuum consolidation seems smaller than that in embankment preloading. Using the back-calculated results of compressibility and flow parameters, the time-settlements re-calculated by 1-D method are in very good comparison with measured data for both conventional preloading and vacuum consolidation considering the vacuum pressure as an induced vertical stress

distributed uniformly in the PVD zone. Analyses of factor of safety from observed pore pressures during embankment construction illustrated that the commonly used stability chart as given by Wakita & Matsuo (1994) is too conservative for PVD improved soft ground. Secondary compression behavior of thick soft ground improved by PVD including back calculation for coefficient of secondary compression and estimation of long term residual settlement are also provided.

The seventh paper is on the Characteristics of Hardpan calcrete of the Nyalau formation and impact on design of shallow foundations is by Sim et al. Nyalau Formation, found in Bintulu Division in Sarawak, Malaysia was formed by a thick array of shallow water marine and paralic sedimentary rocks. The formation is of predominantly sandstone origin and also the lesser known 'limestone' which is described as hardpan calcrete in this paper. Changes of sea levels during the mid-Pleistocene epoch resulting in the formation of raised terrace where marine deposits sedimented and subsequently followed by depositions of the coastal alluviums and inland peat swamps. Laboratory studies and design aspects of shallow foundations are described as well.

The eighth paper is by Seah et al is on ground improvement with vacuum consolidation method in Vietnam. In recent years, vacuum consolidation method has been extensively used in Vietnam on various types of infrastructural projects. The main reason for adopting this method is that the construction cost is relatively close to the conventional prefabricated vertical drain method with less surcharge fill and shorter construction time. Hauling or transporting large amount of fill has been a major problem in most infrastructure projects. With the stringent settlement requirements specified by the Vietnamese Government, ground improvement via vacuum consolidation has become very popular hence attracting various International vacuum consolidation specialists to participate in Vietnamese projects.

The ninth paper is by Tanaka & Lee deals with the dynamic properties of residual soils in Malaysia. The paper examines the dynamic deformation properties of a selected residual soil sample in Malaysia through a series of laboratory tests; including cyclic triaxial tests on the compacted residual soil with a measurement of deformation responses at small strains, and shaking table tests on a small soil block whereby the acceleration responses at different levels were analysed. The results showed that the dynamic deformation properties of the soil, namely the variation of shear modulus over a shear strain were ranging between 10^{-5} and 10^{-2} ; the G values obtained were comparable to those published data.

The tenth paper is by Michael Dobie dealing with the pre-consolidation pressure of the Holocene marine clay of Malaysia. Prediction of the consolidation settlement of very soft alluvial clays in general requires knowledge of the compressibility characteristics of the deposit, but in particular it requires an accurate determination of the preconsolidation pressure. In the OC stress range settlements are likely to be relatively small, but once into the NC range, they can become very large. Therefore the accurate determination of the preconsolidation pressure is essential if reliable consolidation settlement predictions are to be made. This is examined in detail by back-analysing settlement data from two trial embankments which were built over 13m of Holocene marine clay at Juru (south of Butterworth), as part of the geotechnical investigations carried out for the North-South Expressway project over the period 1990 to

1991, then making comparisons to settlement calculated from measured compressibility properties. The definitive determination of preconsolidation pressure is derived from the behaviour of the trial embankment itself, which is then compared with assessments based on undrained shear strength, oedometer test results and piezocone tests.

Eleventh paper by Boon & Ooi deals with FEM analyses and t-z load transfer analyses on critical structures in Kuala Lumpur during tunnelling works. Three case histories are presented: The first one is on a 15 storey tower building seated on a raft foundation. Two modelling approaches were adopted to model the tunnel using the 2-D finite element software PLAXIS, namely the contraction method and the internal pressure method. The second one is on a flyover bridge, of which the pile toes are at an elevation higher than the tunnel crown; and the third one is on the piles of a Light Rail Transit (LRT) bridge in the vicinity of a tunnel. For the latter two case histories, the load transfer t-z and Q-z method (Seed & Reese, 1967), which can be implemented easily into a spreadsheet, to estimate the pile settlements induced by tunnelling is found to be applicable. Finally, insights obtained from the t-z and Q-z analyses are used to explain and refine the influence zones previously proposed by Jacobsz et al. (2004) derived from centrifuge tests. The line joining the points of inflection of multiple subsurface Gaussian settlement profiles (Mair et al., 1993) at different depths was found to correspond to the maximum settlement along the vertical profile, above which the settlement is always increasing.

In the twelfth paper, Tan & Ooi presented top down and bottom up methods of deep excavation in Kenny Hill Formation. The deep excavations are for the Klang Valley MRT underground stations; namely the Bukit Bintang and Merdeka stations which have similar retained depth of 33.5m and 31m respectively and both having 1.2m thick Diaphragm walls. Both the stations are designed with the same design criteria and factor of safety. The selection of type of retention systems, strutting system, construction sequences and timing and instrumentations are discussed.

The predicted and measured diaphragm walls displacements and Strut forces at different stages are then compared and discussed.

In the thirteenth paper Liew & Ho described the problems of Jack-in piling system in Malaysia causing large soil displacement inducing lateral and vertical movements of earlier installed piles, premature refusal to penetration of pile due to intermittent obstruction and also inadequate pile embedment due to shallow end bearing stratum. Pre-boring technique with or without infill are used to overcome the obstruction problem and to ensure adequate pile embedment. The proof loading pile termination criteria appears to produce favourable pile performance and quality assurance.

There are inherent long-term performance deterioration associated with shallow end bearing piles and incomparable short-term and long-term toe resistances, particularly in meta-sedimentary formation, which is prone to stress relief due to softening effect.

The fourteenth paper is by Lee et al on rainfall induced landslides in Malaysia. Landslide constitutes one of the major geohazards in Malaysia. The frequent landslide occurrences are mainly attributed to rainfall

(extrinsic factor) and tropical residual soil (intrinsic factor). This paper provides insights into the mechanisms of rainfall-induced landslides in the country and reviews efforts that have been taken to mitigate the hazard. Despite of the fact that local authorities, government agencies and practitioners have played their enormous roles in producing a better hillside development planning and control in the country, there are still areas for future improvement. The basic understanding of the unsaturated soil mechanics among practitioners and the laboratory facilities to support the theories still need to be enhanced. Besides, the country can move towards a better landslide risk control and management by advancing the studies in run-out behaviours of landslide, establishing database for soil profiles particularly in landslide prone areas, and switching to risk-informed approach of slope stability assessment.

The fifteenth paper by Tan et al is on the “Considerations of Deep Excavation in Kenny Hill and Kuala Lumpur Limestone Formations at the KVMRT”. The paper described the constraints in excavation works in urban environment in the construction of underground space development in the KVMRT stations in the Kuala Lumpur city centre.

The sixteenth paper by W. Mao, I. Towhata, S. Aoyama and S. Goto is on the subject of Grain crushing under pile tip explored by acoustic emission. They thought that the recent practice in design of pile foundations under vertical load relies significantly on either a classic plasticity framework or empiricism. Despite efforts to explore the real pile behavior mainly in 1960s and 1970s, research interest has decreased in the recent times. Accordingly, much is not known about the group pile behavior that is more complicated than that of a single pile. One of the possible reasons for this poor situation is the lack of novel research methodology. In this regard, the authors chose the behavior of both a single pile and group piles subjected to vertical load, and carried out model tests using several new research tools. One important finding was the significant vertical compression of sand under the pile tips which was accompanied by crushing of sand grains. To further investigate the process of grain crushing, the acoustic emission (AE) method was introduced so that “when” and “where” of grain crushing might be identified through the interpretation of micro noise that was generated by crushing. Being different from early studies on AE in geotechnical materials, the present study paid attention to the frequency components of the noise and found that noise by grain sliding is of lower frequency while that by crushing exhibits higher frequency. This finding enabled the authors to interpret more accurately the recorded noise, and the timing and location of grain crush during pile penetration were identified. These findings were verified against the independent graphic interpretation of grain movement (PIV). Consequently, a close correlation between AE intensity and yielding of sand were identified. It is important that grain crushing occurs slightly below the elevation of the pile tip and sand immediately below the tip is significantly compressed but less prone to crushing.

The seventeenth paper is on test embankment supported by vibro stone column related to the high-speed rail project in Malaysia by Yee et al. The Ipoh-Padang Besar Electrified Double Track project is a multibillion-dollar high-speed rail project that involves installation of double tracks, electrification work, construction of stations, bridges and tunnels. Stringent performance specifications governed all aspects of

the project. Various ground improvement techniques were employed, among them Vibro stone columns. From 2008 to 2010, a low, instrumented test embankment supported by Vibro stone columns was built and monitored. The purpose was firstly to demonstrate that Vibro stone columns would not result in “hard points” at the surface even of a low embankment. The second purpose was to investigate the rest periods required for consolidation settlements to occur. Instrumentation and visual inspection show that no “hard points” were observed on the embankment surface, that Priebe’s (1995) method adequately predicts the magnitude of settlements, and that Han & Ye’s (2001) method adequately predicts the rate of settlements. The track has been operational since 2013, and settlement performance has been within the stringent specifications.

Editors:

**Thien Seng Yee,
Swee Huat Chan
and Teik Aun Ooi**

ACKNOWLEDGEMENT

Seventeen papers consisting of four Keynote and three Special Lectures from the recently completed 19th SEAGC and 2rd AGSSEAC which are upgraded together with ten contributed papers are contained in this Malaysia Special 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

Prof. A. S. Balasubramaniam

Dr. Noppadol Phienwej

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Edited by

Thien Seng Yee, Swee Huat Chan and Teik Aun Ooi



Ir. Thien Seng Yee

Ir. Yee graduated in civil engineering from the University of Malaya in 1978 and has over the years worked on projects largely involving heavy plant and building foundations as well as large infrastructures. He had also carried out numerous works on distress evaluations and rehabilitation engineering. In 1994, Ir. Yee set up his own practice, Geo.Consult, to support the construction industry with both expert and specialist advice; in particular on geotechnical engineering aspects. His participation in recent projects of significance are the Kuching Deep Water Port, Shah Alam Expressway, North-South Expressway, Kuantan Port Inner Harbour Development, Kuantan-Kertih Railway and the Rawang-Ipoh Double Tracking Railway. He has authored/co-authored more than a dozen technical papers in local and international conferences. Ir. Yee is an expert witness and accredited checker registered with the Board of Engineers Malaysia for the design of geotechnical engineering works. Ir. Yee is the Chairman of the Geotechnical Engineering Technical Division of the Institution of Engineers Malaysia for Session 2015/2016.



Ir. Dr. Swee Huat Chan

Ir. Dr. Swee Huat Chan is a registered Professional Engineer with the Board of Engineers, Malaysia since 2005. He graduated with a 1st Class Honors Degree in Civil & Structural Engineering from the Universiti Kebangsaan Malaysia in 1997. He obtained his Ph.D degree from the National University of Singapore in 2003. He worked as a Geotechnical Engineer in SSP Geotechnics Sdn. Bhd. for about 5 years before he joined Dr C.T. Toh Consultant as a Resident Engineer for about 2 years. He is one of the founders and directors of Geo-Excel Consultants Sdn. Bhd., a geotechnical engineering consulting firm. For the past 15 years, he has involved himself in analysis, design and construction of various geotechnical works and aspects including shallow & deep foundations, deep excavations & earth retaining structures, slope stability analyses & stabilization, landfill liner systems, seepage analyses, assessments of tunnelling methods, soil improvement techniques (highway, railway, airport, etc.), geotechnical failure investigations, 3-D finite element analyses, etc. He also served as an independent expert witness in several lawsuit cases in the High Court of Malaya at Kuala Lumpur. He is currently the Honorary Treasurer for Malaysian Geotechnical Society, Committee Member for the Geotechnical Engineering Technical Division in The Institution of Engineers, Malaysia and Member of Working Group on Drafting of Malaysia National Annex to Eurocode 7: Geotechnical Design - Part 2: Ground Investigation and Testing.



Ir. Dr. Teik Aun Ooi

Ir. Dr. Teik Aun Ooi obtained his Bachelor of Civil Engineering and Master of Engineering from Auckland University 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 played a 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 prestigious 19th Professor Chin Fung Kee Memorable Lecture in 2009. He frequently delivered lectures to the final year University engineering students.

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TABLE OF CONTENTS

<u>List of Papers</u>	<u>Page</u>
1. Professionalism and Ethics of Engineering By Z.C. Moh	01-03
2. Recent Advances in Pile Testing and Diaphragm Wall Constructions in Japan By K. Ishihara	04-23
3. Innovation in Soil Improvement Methods By J. Chu	24-34
4. Lessons Learned from Designing High-rise Building Foundations By H.G. Poulos	35-49
5. A Critical Review of Rail Track Geotechnologies Considering Increase Speeds and Axle Loads By Buddhima Indraratna, Sanjay Nimbalkar and Chalachat Rujikiatkamjorn	50-60
6. Performance and Analyses of Thick Soft Clay Deposit Improved by PVD with Surcharge Preloading and Vacuum Consolidation - A Case Study at CMIT By P.V. Long, L.V. Nguyen and A.S. Balasubramaniam	61-70
7. Characteristics of Hardpan Calcrete of the Nyalau Formation and Impact on Design of Foundations By A.C.Y. Sim, D.E.L. Ong, L.Y. Tai, W.H. Ting,, E.P.S. Chai and J. Bachat	71-79
8. Ground Improvement via Vacuum Consolidation Method in Vietnam By T.H. Seah, T.B. Kim and T.D. Nguyen	80-88
9. Laboratory Study on Dynamic Properties of Compacted Residual Soil in Malaysia By Y. Tanaka and M.L. Lee	89-96

10. On The Preconsolidation Pressure: Experience Based on Testing the Holocene Marine Clay of Peninsula Malaysia By M.J. Dobie	97-108
11. Tunnelling Past Critical Structures in Kuala Lumpur: A Discussion of Case Histories with Insights from Finite Element Analysis and T-Z Load Transfer Analyses By C.W. Boon and L.H. Ooi	109-122
12. A Comparison of Performance of Deep Excavation using the Top Down and Bottom Up Methods in Kenny Hill Formation By J.G. Tan and L.H. Ooi	123-133
13. Fallacy of Capacity Performance & Innovation Improvement of Jack-In Piling in Malaysia By Liew, S.S. and Ho, S.F.	134-143
14. An Overview of Slope Failure during Monsoon Seasons in Malaysia By M.L. Lee, Y. Tanaka and S.Y. Chong	144-151
15. Considerations of Deep Excavation in Kenny Hill and Kuala Lumpur Limestone Formations at the KVMRT By J.G. Tan, L.H. Ooi & H.K. Yeoh	152-163
16. Grain Crushing under Pile Tip Explored by Acoustic Emission By W. Mao, I. Towhata, S. Aoyama and S. Goto	164-175
17. A Vibro Stone Column Supported Test Embankment for a High-speed Rail Project in Malaysia By Y.W. Yee, L.H. Ooi and J. Daramalinggam	176-183

Cover Photographs:

1. Photo 1 Weathering profile of tropical residual soil (After Lee, Tanaka and Chong, 2016)
2. Photo 2 Shaking table test on soil block (After Tanaka and Lee, 2016)
3. Photo 3 Petrographic thin section of hardpan calcrete (After Sim et al., 2016)
4. Photo 4 Jeddah Tower, Saudi Arabia (After Poulos, 2016)
5. Photo 5 Burj Khalifa Tower, Dubai (After Poulos, 2016)
6. Photo 6 Vacuum Consolidation, Vietnam (After Seah et al, 2016)
7. Photo 7 Bird-eye view of pier platform (After Ishihara, 2016)