Geotechnical Engineering Journal of the SEAGS & AGSSEA Vol. 47 No.1 March 2016 ISSN 0046-5828

ENGINEERING

Journal of the

SOUTHEAST ASIAN GEOTECHNICAL SOCIETY

&

ASSOCIATION OF GEOTECHNICAL SOCIETIES IN SOUTHEAST ASIA

AGSSEA

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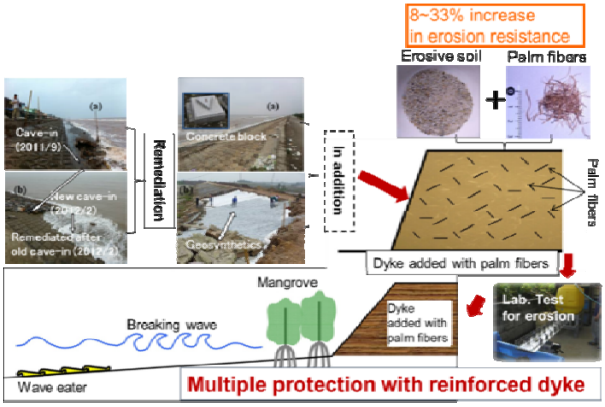
Editors: Dr. Phung Duc Long & Prof. San-Shyan Lin

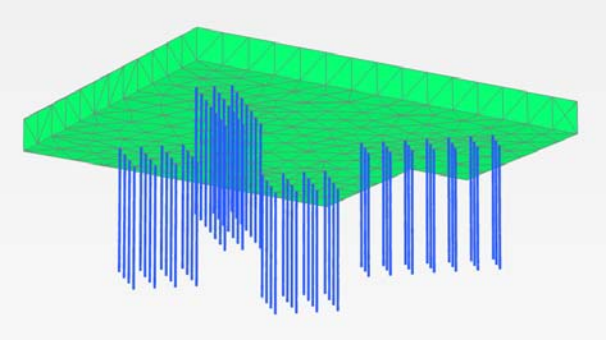


Multiple protective measures used in coastal areas

(After Yasuhara *et al.*, 2016)

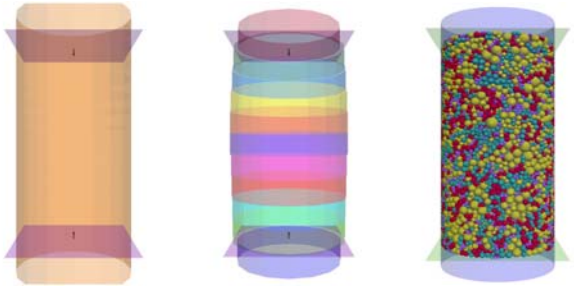
Example of erosional scene of river bank in the Mekong Delta

(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

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

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 habours, etc have appeared in Vietnam. Thousands of kilometers of highway have been constructed. New metro projects have been started both in Hanoi anh 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

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Geotechnical Engineering Journal of the SEAGS & AGSSEA Vol. 47 No.1 March 2016 ISSN 0046-5828

GEOTECHNICAL ENGINEERING

March 2016: VIETNAM SPECIAL ISSUE

Editors: Dr. Phung Duc Long & San Shyan Lin

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GEOTECHNICAL

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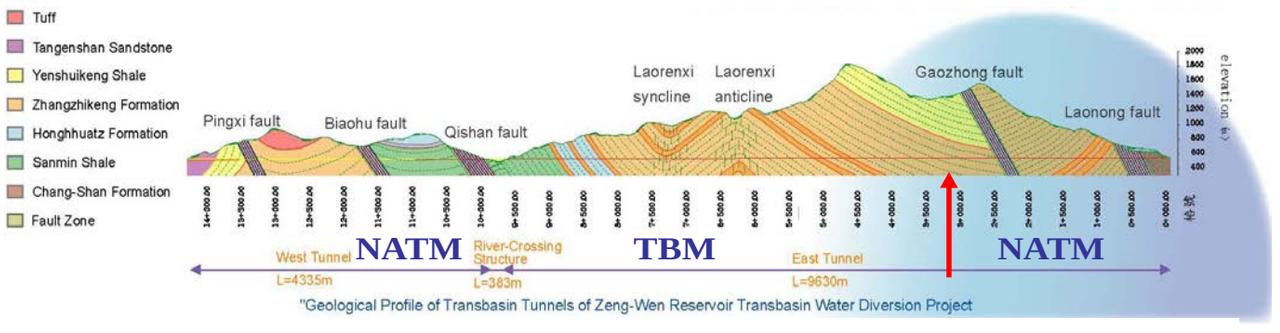

Geological profile along tunnels in TDT project

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

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 Geo-textile 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 40yers. 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

"Expriences 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 Affair. 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 particularly, 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 9thInternational 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

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 shot 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. Inclinometer 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: CHINESE TAIPEI SPECIAL ISSUE

Editor: Professor Meei-Ling Lin

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Geotechnical Engineering Journal of the SEAGS & AGSSEA Vol. 47 No.3 September 2016 ISSN 0046-5828

GEOTECHNICAL

ENGINEERING

Journal of the

SOUTHEAST ASIAN GEOTECHNICAL SOCIETY

&

ASSOCIATION OF GEOTECHNICAL SOCIETIES IN SOUTHEAST ASIA

AGSSEA

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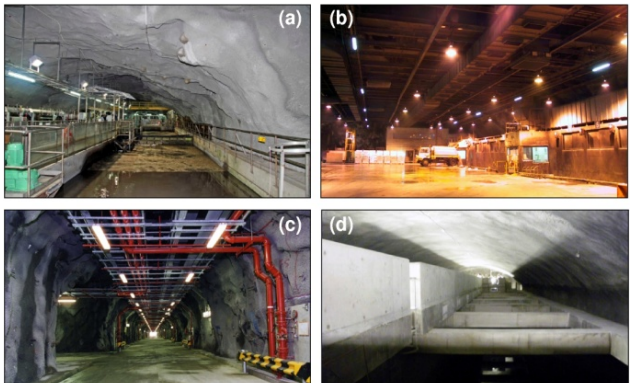
Editor: Sing Lok Chiu (Hong Kong Part) and Tiong Guan Ng (Singapore Part) & San Shyan Lin (Contributed Papers)

1972 Po Shan landslide in Hong Kong

(After Ho and Cheung 2016)



Examples of purpose-built caverns in Hong Kong

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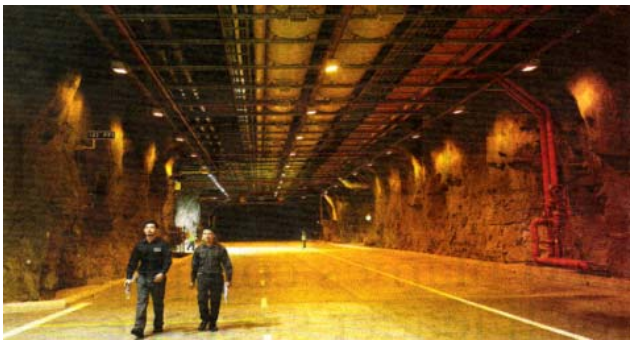
Layout plan of DTL3 alignment and location of C922 ORT in Singapore (After Ng and Low 2016)



Underground Ammunition Facilitycavern in Singapore

(After Zhou and Zhao, 2016)

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 L andslip 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

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 tratemenent 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 submisions makes futher 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
Dr. 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)*

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PART C - Contributed Papers

Geotechnical Engineering Journal of the SEAGS & AGSSEA

Vol. 47 No. 4 December 2016

ISSN 0046-5828

GEOTECHNICAL ENGINEERING

Journal of the

SEAGS Southeast Asian Geotechnical Society

AGSSEA ASSOCIATION OF GEOTECHNICAL SOCIETIES IN SOUTHEAST ASIA

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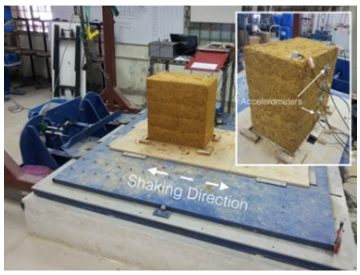
EDITORS:

Thien Seng Yee, Swee Huat Chan and Teik Aun Ooi

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



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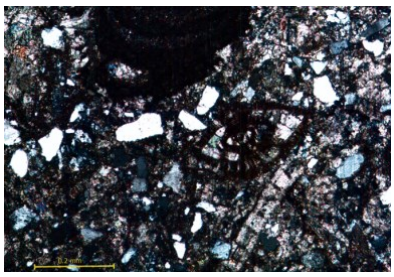

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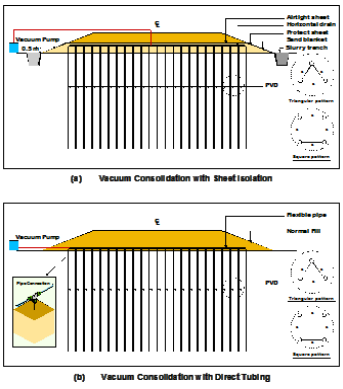
Jeddah Tower, Saudi Arabia (After Poulos, 2016)

Burj Khalifa Tower, Dubai (After Poulos, 2016)



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

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

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 is 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 lessions 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 ch value is dependent on the assumptions of smear effects including smear zone ratio, ds/dm and permeability ratio, Rs = kh/ks. For ds/dm = 2 as commonly used, the back-calculated ch value is directly proportional to Rs and the value of Rs 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 stain 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

December 2016: MALAYSIA SPECIAL ISSUE

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 Universiity in 1966 and 1968 respectively. He obtained his PhD from University of Sheffield in 1980. He was the Co - Organizing Chairman of the recently concluded SEAGC2016. He is the immediate Past President of the Southeast Asian Geotechnical Society (SEAGS), Founder Chairman of the Association of Geotechnical Societies in Southeast Asia (AGSSEA). He is a Past President of the Malaysian Institute of Arbitrators (MIArb). He is the Immediate Past ICE Country Representative for Malaysia (2000 - 2015), Founder Chairman of IEM Tunnelling and Underground Space Technical Division (TUSTD), Founder Chairman of IEM Consulting Engineering Special Interest Group (CESIG), He is an Honorary Fellow of The Institution of Engineers, Malaysia (Hon. FIEM), Fellow of the Institution of Civil Engineers (CEng FICE), Fellow of the MIArb (FMIArb), Fellow of Malaysian Society of Adjudicators (FMSA) and Fellow of Asean Academy of Engineering and Technology (FAAET). Dr. Ooi has fifty years of experience in the Construction Industry. He spent his initial fourteen years with the Public Works Department Malaysia before leaving to work in the private sector where he spent seventeen years working in the construction sector. He play major role in the Johore Baru Causeway widening and the design and construction of Senai Airport in 1970s. He was the Project manager for the Wisma Saberkas Building Project in Kuching in 1980s. He was Project Director for the Design and Construction supervision of the New Kuching Deep Water Port at Kampung Senari in 1990s. He started his consultancy practice in 2000 specialising in Civil and Geotechnical Engineering works. Dr. Ooi is a practicing Consulting Engineer, An Expert Witness in Court and in Arbitration, An Accredited Checker, An Arbitrator and An Adjudicator. He is a member of the Accredited Checker Committee of the Board of Engineers, Malaysia. Dr. Ooi devoted much of his time in honorable public service in continuing education of engineers and development of Malaysia Annexes for Eurocode 7 and 8. He is an independent executive director of IEM Training Centre Sdn Bhd since 1992. In 2013 he was appointed executive director of the IEM Academy Sdn Bhd. He has been Organizing Secretary and Chairman of numerous IEM Workshops, Seminars, and Conferences since 1970s. He was responsible for forming five active ICE Student Chapters in Universities in Kuala Lumpur. Dr Ooi conducted touring lectures in geotechnical engineering to Malaysia, Vietnam, Thailand, Cambodia, Laos, Myanmar and Philippines. In Malaysia he was invited to deliver the prestigous 19th Professor Chin Fung Kee Memorable Lecture in 2009. He frequently delivered lectures to the final year University engineering students.

GEOTECHNICAL ENGINEERING

December 2016: MALAYSIA SPECIAL ISSUE

Edited by

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

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Vol. 48 No. 1 March 2017

ISSN 0046-5828

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Kazuya Yasuhara, Farrokh Nadim and **Dennes Bergado**

Geo-disasters in Japan in the Context of Climate Change
(After K. Yasuhara, S. Kawagoe and K. Araki, 2017)

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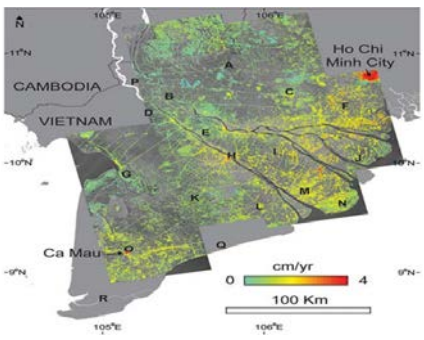

Subsidence and shoreline retreat in the Ca Mau Province – Vietnam: Causes, consequences and mitigation options *(After K. Karlsrud , B.V. Vangelsten and R. Frauenfelder, 2017)*

GEOTECHNICAL ENGINEERING

March 2017: Climate Change, Environmental Geotechnics and Geo-hazards

Edited by
Kazuya Yasuhara, Farrokh Nadim and **Dennes Bergado**

Kazuya Yasuhara

Kazuya Yasuhara is Professor Emeritus of Ibaraki University in Japan; His academic career started in Kyushu University where he was from 1968 to 1978, earning a Doctoral Degree as well. He was then a Professor at Ibaraki University from 1990 to 2007. Prof Yasuhara was the International Project Coordinator at the Institute of Global Change Adaptation Science from 2010 to 2015. He was also a Review Editor for IPCC AR 5 from 2010 to 2014. Since 2015, Prof. Yasuhara is a Specially appointed researcher at Ibaraki University.

Prof. Yasuhara was at University of Illinois Urbana- Champaign in Illinois, USA from 1979-1981 and was a Post Doctorate Research Fellow at the Norwegian Geotechnical Institute from 1986 to 1987. Prof. Yasuhara was the recipient of several prestigious awards: ASCE Best Paper Award in 1999; JGS Award for Meritorious Service in 1999; Groundwater Science and Technology Award (IAHR) in 2000; JGS Award for the Best Research Achievement in 2004; Best Paper Award from Japan Chapter of International Geosynthetics Society in 2006; and JGS Meritorious Research Award for Ground Environment in 2008. His current research interest is in Climate change-induced compound geo-disasters in Asia-Pacific regions and their adaptation countermeasures against earthquake-induced settlements of infrastructures. Prof. Yasuhara is the author of a very large number of publications in this field and others in Geotechnics.

Farrokh Nadim

Dr. Dr Farrokh Nadim is the director of the Centre of Excellence, the "International Centre for Geohazards" (ICG), at the Norwegian Geotechnical Institute (NGI). He has a BSc in structural engineering from Sharif University of Technology in Iran, and MSc and ScD degrees in civil engineering from Massachusetts Institute of Technology (MIT). Dr Nadim came to NGI in 1982 on a post-doctoral fellowship and joined NGI as a fulltime employee in 1984. His major fields of work are related to landslides and geohazards, risk and reliability analysis, geotechnical earthquake engineering, behaviour of geotechnical structures under cyclic and dynamic loading, and offshore foundation engineering. He is author or co-author of over 80 scientific publications, and Chair of Technical Committee 32 of ISSMGE: "Engineering practice of risk assessment and management". Since 2003 Dr Nadim has been an adjunct professor at both the Norwegian University of Science and Technology (NTNU) and University of Oslo (UiO).

Dennes Bergado

Prof. Bergado (Dennes) was in the Geotechnical Engineering batch that graduated from AIT in 1976. After working for a while in Philippines, Prof. Bergado studied at Utah State University in USA on a Full Bright Scholarship and worked with Prof. Loren Anderson. Prof. Bergado joined AIT as an Assistant Professor in 1982. At AIT in the early years Prof. Bergado was involved with many major Sponsored Research Projects including the USAID Funded Welded Wire Mechanical Stabilized Earth and Geosynthetics in Embankments on Soft Clays. Prof. Bergado was also deeply involved with the PVD Soft Ground Improvement Project at the Second Bangkok (Suvarnabhumi) Airport Site with the Airport Authority of Thailand. The Doctoral Students of Prof. Bergado were: Prof. Shivashankar, Prof. Chai, Dr. Long, Dr Panich, Dr Lorenzo, Dr Sompote, Dr Lai, Dr Abuel-Naga, Dr Chairat, Dr. Pittaya, Dr Jaturonk, and Dr Tawatchai to name a few. He successfully supervised a total of 17 doctor and 160 master graduates. Prof. Bergado wrote 2 books in soil/ground improvement, edited 22 conference proceedings with more than 140 journal and 280 conference papers. Prof. Bergado also edited the Volume on Geotechnical Engineering in SE Asia for the Golden Jubilee Conference at San Francisco in 1985. Prof. Bergado was associated with the Southeast Asian Geotechnical Society from the time he joined AIT, earlier as Editor of the Journal (1996-2000) and later became the Secretary General of SEAGS (2001-2012). He also initiated the Asian Center for Soil Improvement and Geosynthetics (ACSIG) and founded the International Geosynthetics Society (IGS)-Thailand Chapter. Currently, he is serving his second term as elected member of the IGS International Council. Prof. Bergado spent his Sabbatical at Saga University.

GEOTECHNICAL ENGINEERING

PREFACE

There are fourteen papers in this Issue edited by Yasuhara, Nadim & Bergado. The first paper is by Yasuhara et al on Geo-disasters in Japan in the Context of Climate Change. The authors say: Japan is an area affected strongly by land surface upheaval and by climate change instability. Background evidence of increasing and magnifying geo-disasters includes the following: (i) frequent and extremely severe torrential rainfall; (ii) high and increasing frequency of strong earthquakes (5+ and 6- as the Japan Meteorological Agency seismic intensity scale); and (iii) typhoons with magnified damage effects. Based on a review of that information stated above, an attempt has been made to overview the present situation and future trends of geo-disasters in the context of climate change and to present possible adaptive measures against disasters. Particularly, emphasis is assigned to the importance of the combined effects of plural events, which increases the probability of extreme events, sometimes triggering devastating consequences. Adaptive measures against climate change-associated geo-disasters are presented by classification into software and hardware. Special emphasis is devoted to the availability of information and communication technology (ICT) and information, communication and robot technology (ICRT) involving devices such as IC-sensors and un-crewed vehicles (UAV, drones), which are useful in early warning systems and in simple monitoring systems.

The second paper is by Do Minh Duc et al on climate change impacts in a large-scale erosion coast of Hai Hau district, Vietnam and the adaptation. It seems among the effects of global warming, sea level rise (SLR) and severe typhoons pose the greatest threat to the stability of human settlements along coastlines. Therefore, countermeasures must be developed to mitigate the influences of strong typhoons and persistent SLR for coastal protection. This study assesses climate change impacts on coastal erosion, especially in two projected SLR scenarios of RCP2.6 and RCP8.5. The results show that SLR and severe typhoons lead to the increase of coastal erosion, beach lowering and scour. Moreover, as in projected SLR scenarios, average waves in high tide can cause severe soil erosion at inner slopes and lead to dyke failure by 2060. The paper highlights the need for additional geotechnical engineering measures to protect the coast of Hai Hau district against SLR and severe typhoons. Among the alternatives available for countering these threats, applying soil stabilization and soil improvement combined with geosynthetics are promising strategies for coastal structures. Hybrid structures can be used with earth reinforcement and soil improvement. Additionally, the paper emphasizes the importance of multiple protective adaptations, including geosynthetics and ecological engineering measures against climate change-induced severe erosion on the coast of Hai Hau district.

Karsrud et al in the third paper described subsidence and shoreline retreat in the Ca Mau Province – Vietnam: Causes, consequences and mitigation options: The authors say in the past decades, the Ca Mau province located at the southern end of Vietnam, has experienced significant land-loss. Satellite data suggest that a loss of land, or a retreat of the shoreline, ranging from about 100 m to 1.4 km have occurred over the past 20 years or so. In addition to the retreating coastline, the Ca Mau coastline has experienced loss of mangrove forests and salt-water intrusion into canals and rivers in the region. A study undertaken in collaboration between Vietnamese and Norwegian institutions has tentatively concluded that the main cause of the land-loss is subsidence of the ground surface as a result of ongoing groundwater pumping. The experienced land-loss may be further enhanced by a climate change related sea-level rise. Large parts of the land area in Ca Mau lie less than 1.5 m above sea-level. The subsidence settlements may already have reached 40 to 80 cm in some places, and the present subsidence rates may correspond to 2-4 cm/year. Recent satellite based data using In SAR technology (Interferometry Synthetic Aperture Radar) confirm that significant subsidence is on-going in all provinces in Vietnam from Ho Chi Minh City and southwards. If no actions are taken soon, the implication will be that these provinces are lost to the sea within a time frame of a few decades.

The only realistic way to prevent such subsidence settlements is to greatly reduce groundwater pumping in the area, and replace it with water from other sources. Also in light predicted climate-change related sea-level rise, some physical barriers may also be required to protect the region against flooding. It is

recommended to immediately initiate an observational program and supplementary analyses to verify the present and future subsidence of the ground surface in Ca Mau. This is to ensure that remedial actions are planned for and implemented before it is too late.

In their paper (fourth one) Yahaya et al present rainfall erosivity variability for Penang Island in Malaysia. Rainfall erosivity considers the rainfall amount and its intensity. This is an important parameter for soil erosion risk assessment under future land use and climate change. Comparisons of all climatic parameters show that rainfall is directly involved in the loss of soil quality during torrential rain. The effect of rainfall erosivity in Northern part of Malaysia was considered for two stations, Bukit Berapit and Air Itam. Monthly as well as annual rainfall was obtained from the Department of Drainage and Irrigation, Malaysia for thirty years (1983-2012). Trends analysis of the rainfall data were obtained for 30 years that shows trends for mean annual rainfall. This was conducted using Mann-Kendall trend analysis and Sen's slope tests. Trend analysis shows that there is negative significant difference in mean annual rainfall for the studied period for Air Itam. The Fournier indexes were used to determine the effect of extreme rainfall events towards soil erosivity. Bukit Berapit recorded 3.33% cases of severe impact using Fournier index and 13.33% cases of high impact using modified Fournier index. The result shows that there is a relationship between rainfall trends and soil erosivity.

The fifth paper is on the influence of increased precipitation on the transient seepage through levees during flood events. This paper is by Scheurmann et al. The transient seepage through levees during a flood event depends on several factors, such as the initial water content condition within the levee as a result of former flood and precipitation events which is frequently neglected. Results of experimental and numerical investigations are presented which show the importance of the initial water content distribution on the resulting transient seepage. Analytical methods for calculating the transient seepage through levees are introduced. The modified method after Brauns (1999) allows for the determination of the seepage through levees under consideration of partly saturated conditions. The initial conditions for the transient seepage can be chosen based on simple considerations related to the field capacity or the effective infiltration of water due to precipitation.

Hazarika in his paper sixth in the series discuss the use of low carbon and low cost (LC2) Materials in climate change adaptation measures. Material recycling of waste tires, which reduces the release of greenhouse gases, for protecting coastal structures from potential natural hazards is proposed here. A new technique using waste tires behind sea walls to protect them from the damage due to impact force of tsunami is described. Cultivation of suitable plants inside the tires was proposed and field tests on planting trees that can grow in saline soil conditions were performed to see whether tire structures can preserve the greenery of the area. A physical model for tsunami impact force simulation was also developed to evaluate the reduction effect of tsunami impact force by the tire structures. Results of this research, if implemented, is not only expected to contribute towards economic countermeasures against natural hazards, but also will go a long way towards providing a sustainable solution for infrastructure development in the future.

Lee et al are the authors of the seventh paper on performance monitoring of bridge foundations under multi-hazards
In an effort to proactively monitoring the safety of bridge foundations so as to probe the possible performance of bridge foundation during natural hazards such as floods, debris flows, rainstorms, and typhoons, an intelligent monitoring system was developed by the authors and had applied to several bridges. In this paper, theoretical background and development will be firstly described. Two case histories will then be presented to describe performance of bridge foundation during natural hazards. Such information will be also further discussed by integrating environment factors such as rainfall amount and flow velocity. Research progress presented in this paper is hoped to be helpful in understanding performance of bridge foundation during hazards so as to provide insights of pre-warning of bridge safety.

The eighth paper by Chanmee et al is titled analysis and simulations of flood control dikes and erosion protection schemes using PLAXIS FEM 2D and SLIDE computer softwares. In 2011, Thailand has suffered from devastating flooding due to climate change. During this time, 2 typhoons from the Pacific area went

straight across Vietnam to Northern Laos and Northern Thailand instead of the usual path to Taiwan and Japan. Subsequently, huge flooding damaged many infrastructures and overtopped flood protection dikes of many industrial estates and educational institutions in the Central Plain of Thailand such as at Hi-Tech Industrial Estate, Bang Pa-In Industrial Estate, Navanakorn Industrial Estate and Asian Institute of Technology. The same phenomenon also occurred in Laos PDR which caused unusually heavy rains and widespread river flooding in 2011.

Consequently, slope failures occurred along National Road 1B (NR 1B) in Pongsaly Province in Northern Laos due to undercutting erosions at the lower slopes by the adjacent flooded river. To evaluate the stability of these protection structures, finite element and limit equilibrium methods were utilized. PLAXIS 2D software was used to analyze the slope stability of improved flood protection dikes and erosion control schemes at low and high water levels incorporating the various supporting and reinforcing materials such as geosynthetics, concrete sheet pile and concrete slab. Moreover, the PLAXIS 2D software was also utilized to predict the vertical deformations (settlements) of improved flood protection dikes in cases of additional embankment height and at different cases of flood water levels. In addition, the SLIDE software was used to predict the value of the factor of safety by using limit equilibrium method for the improved flood protection dikes and erosion control schemes.

In the subsequent paper nine in the series Araki et al deal with arresting rainfall-induced red soil runoff in a farmland by inhibitory adaptation measures. Climate change-induced red soil erosion in Okinawa of Japan has become widely recognized due to the increased frequencies of heavy rainfall. Approximately 85% of runoff from farmland is accounted as a source of the red soil erosion. In this study, field experimental plots were conducted in Ginoza village in Okinawa to investigate the effectiveness of potential adaptation measures in arresting the red soil erosion. A physical model for estimating a sediment volume of soil erosion was derived based on grain size distribution. The maximum particle sizes were derived as a function of rainfall intensity, initial soil conditions and strength parameters of the surface soil. The measured maximum particle sizes of the discharged red soil were agreed well with the model results and could offer the basis for determining an appropriate method of adaptation based on geotechnical aspect.

Umino et al in the tenth paper deal with iron and steel slag properties and mechanisms for carbon dioxide fixation in a low-carbon society. The paper presents carbon dioxide (CO2) fixation properties of an iron and steel slag containing calcium, in order to contribute to a geotechnical application for the formation of a sound material-cycle society and a low-carbon society. To investigate the properties of CO2 fixation, CO2 fixation tests with constant flow were conducted. Results show that when the CO2 concentration 4500 μL-$_{CO2}$/L was flowed in a specimen by 0.05 L/min, for a non-aged steelmaking slag, the amount of CO2 fixed was the maximum: 0.04 g- CO2/g-slag. The amount of CO2 fixed in the steelmaking slag resulted from about 20% of soluble calcium in the chemical reaction. Therefore, it is possible that the quantity of CO2 fixation can be evaluated from the viewpoint of the mechanism of CO2 fixation using the quantity of water soluble calcium.

Kusakabe et al in the eleventh paper deal with the development of gross national safety index for natural disasters. After the Great East Japan Earthquake on March 11, 2011, it appeared that Japan was extremely vulnerable to natural disasters and lack of adequate social systems for mitigating natural disasters. The authors advocated a need for the development of safety index systems for natural disasters for policy makers and decision makers to prioritize mitigation measures to be implemented. The World Conference on Disaster Reduction in Kobe in 2005 adopted the Hyogo Framework for Action, which clearly states the urgent need for developing vulnerability index. An extensive literature survey was firstly conducted to find out the State of the Art regarding to the development of systems of indicators of disaster risk and vulnerability at national and sub-national scale. The survey indicates that the system of indicators such as World Risk Index (WRI) is widely accepted. By modifying the WRI index, a new index named GNS (Gross National Safety for natural disasters) was developed in this study. Risk in GNS is defined by Hazard x Exposure x Vulnerability. Five natural events are considered in 2015 version of GNS, including earthquake, tsunami, storm surge, sediment related disaster event, and volcanic activity. An initial calculation was carried out by using various big data available open to public. The results of disaster risk and vulnerability

are presented in the prefectural scale in Japan. Our intension is not to provide the ranking of GNS but to offer the policy and decision makers a piece of scientific information for selecting highest priority measures for mitigation in a rational manner. A few commentary remarks are added to include the impact of climate change on natural disasters in the safety index system.

The twelfth paper by Yuan et al. describes the flooding hazards and potential risks due to heavy rain and sea level change in Shanghai, China. Current sea level change is mainly induced by global warming which is believed to increase the sea level if sustained for a sufficiently long period of time. Many coastal cities around the world have suffered adverse effects as a consequence of sea level change. Shanghai is a coastal city which is located on the estuary of the Yangtze River with an elevation ranging from 3 to 4 m. Its geological and climatic conditions make the city sensitive to flooding risk caused by heavy rain and sea level change. This paper analyses the recent sea level change and heavy rainfall in Shanghai. Regional rates of sea level change can be divided into i) the rate of eustatic sea level change; ii) tectonic movement of the continent; and iii) land subsidence in Shanghai. A correlation analysis shows that the number of local torrential rains and short duration torrential rains correlates with sea level change. Incidents including pluvial flooding, sea water intrusion and potential damage to coastal structures will be more serious if the rate of sea level change continues to rise. To protect the environment and to control economic losses, more countermeasures should be established to prevent the potential hazards.

The thirteenth paper by Soralump and Chaithong is on the modeling impact of future climate on stability of slope based on general circulation model. Slope failures are one of geo-hazard which are one of the most dangerous and occur very often. Climate is an important role in stability of slope. In many cases rainfalls induce slope instability and lead to slope failure or landslide whereas evaporation might stabilize slope. Climate change due to greenhouse effect and global warming might affect precipitation and evaporation patterns in the future and influence future slope failure. Therefore, the paper proposes a method for assessment impact of climate change on slope failure occurrences based on general circulation model (GCM). Methodology combines between climate scenarios as a result of general circulation model and modified critical antecedent precipitation index model. GCM results are downscaled with dynamical-statistical technique to derive local climate. Analysis found that trends of susceptibility of soil instability vary and depend on climate in each year period.

The fourteenth paper by Ghosh and Pal describes the geotechnical measures for Uttarakhand Flash Flood in 2013 in India. In many “Run of the River” hydro-electric projects in the four main states of northern India have been frequented by “Cloud Burst” induced flash flood since 2003, which is primarily attributed to climate variability and land use pattern changes. Given the ageing population of vulnerable constructions along the hilly terrains, safety issues require more attention in the form of technical auditing cum inspections, routine monitoring, emergency drills, surveillance systems, and regularly updated emergency action plans. In addition to these accelerated events of “cloud burst” induced flash flood in the hilly region has opened up Dam safety issues, which are debated in the court of law for which geo-professional intervention have to be looked into. The climatic and other geo-morphological changes that might have caused Uttarakhand Flash Flood in 2013 are explained. Damages to the geotechnical structures in the form of excessive erosion, landslides, siltation of catchment area of several Dams in Uttarakhand state of India are described with some illustrations of landslide mitigation by indigenous bio-engineering solution as one the means of rehabilitation measures.

Editors:
Kazuya Yasuhara,
Farrokh Nadim
and Dennes Bergado

ACKNOWLEDGEMENT

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

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

GEOTECHNICAL ENGINEERING

March 2017: Climate Change, Environmental Geotechnics and Geo-hazards

Edited by
Kazuya Yasuhara, Farrokh Nadim and **Dennes Bergado**

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Geotechnical Engineering Journal of the SEAGS & AGSSEA

Vol. 48 No. 2 June 2017

ISSN 0046-5828

GEOTECHNICAL ENGINEERING

Journal of the

SEAGS Southeast Asian Geotechnical Society

AGSSEA ASSOCIATION OF GEOTECHNICAL SOCIETIES IN SOUTHEAST ASIA

Sponsored by

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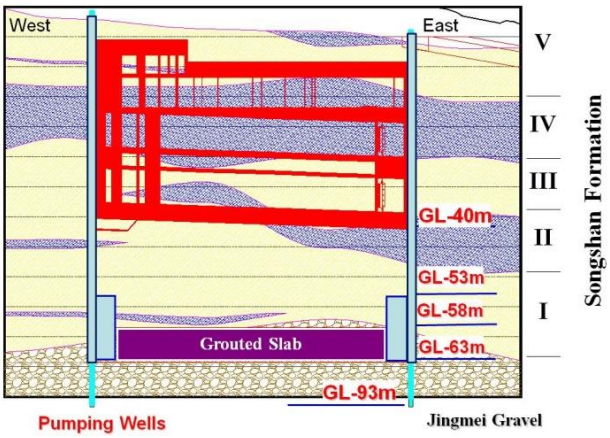
Indexed by EI since 1970 Scopus since 2001



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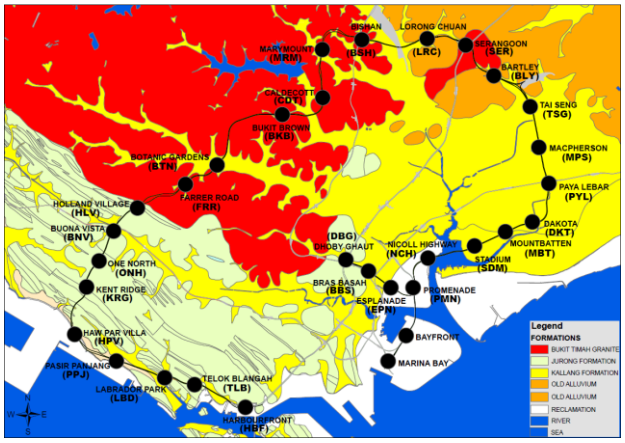

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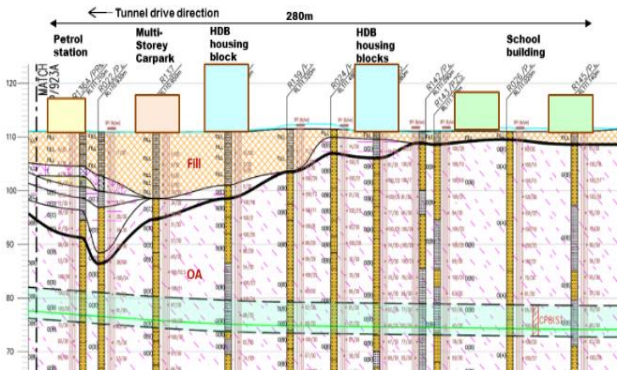

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GEOTECHNICAL ENGINEERING

June 2017: Papers on Mass Transit Projects & also contributed papers

Edited by
Kok Hun Goh, Jeyatharan Kumarasamy, Richard Hwang & San Shyan Lin

Kok Hun Goh

Dr Goh obtained his Bachelor of Engineering and Masters of Engineering from the National University of Singapore, and received his doctorate from the University of Cambridge. He has more than 15 years of geotechnical engineering experience, and has been involved in the design aspects of several road and rail infrastructure projects in Singapore. He is currently a deputy director who looks after the Geotechnical & Tunnels Division in the Land Transport Authority of Singapore. He is registered as a professional engineer in Singapore with specialisation in geotechnical engineering as well as a chartered professional engineer.

Jeyatharan Kumarasamy

Dr Jeyatharan Kumarasamy graduated from Cambridge University, UK (Ph.D. in Soil Mechanics) in 1992 and University of Peradeniva, Sri Lanka with B.Sc. (Eng.) First Class Honours in 1985.

He worked as senior geotechnical engineer for nearly five years with Parsons Brinckerhoff in Singapore Office. Since 2002, Jeyatharan is working with Land Transport Authority (LTA) on several major rail and road underground projects. He currently holds the Assistant Chief Specialist (Geotechnical) position in LTA.

Richard Hwang

Dr. Hwang received his bachelor degree from the National Taiwan University, master degree from North Dakota State University and doctor degree from the University of California at Berkeley. His doctoral research was on soil-structure interaction in earthquakes and he is one of the original authors of the finite element computer programmes FLUSH and QUAD4 for seismic studies. He was manager of Singapore Branch of Kiso-Jiban Consultants, and served as leader of a team of geotechnical engineers serving Singapore Mass Rapid Transit Corporation, which was later merged to Land Transport Authority, for the Phase 1 construction of the Singapore metro systems. At Moh and Associates, Inc. he led a team serving Department of Rapid Transit Systems providing geotechnical engineering consulting services on the construction of Taipei Metro.

Dr. Hwang is specialized in numerical analyses, foundation engineering, and underground constructions and has authored and co-authored 160 technical papers. He delivered the 7th Geotechnical Engineering Heritage Lecture at Taiwan Professional Engineers Association and received Geotechnical Engineering Heritage Award from Sino-Geotechnics Research and Development Foundation.

San Shyan Lin

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

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

GEOTECHNICAL ENGINEERING

PREFACE

There are seventeen papers in this Issue; the first twelve are papers edited by the Guest Editors: Kok Hun Goh, Jeyatharan Kumarasamy and Richard Hwang on Mass Transit Projects; additionally there are five contributed papers processed by our in-house editors.

The first paper is by R. N. Hwang and Z. C. Moh on Deep Excavations in Taipei Metro Construction: Discussed herein are the geological features of the Taipei Basin relevant to the construction of Taipei Metro and the deep excavations carried out with emphasis on back analyses of wall deflections. The excavation at the crossover next to G17 Station of the Green Line is adopted as an example to illustrate the applications of wall deflection paths and reference envelopes. The importance of calibrating inclinometer readings to account for the movements at the tips is confirmed by numerical analyses; and the assumption that movements at the joints between the struts at the first level and the diaphragm walls would be negligible in subsequent stages of excavation once these struts are preloaded is verified. Furthermore, it is proved that the concept of wall deflection path is very useful to quantify the influence of various factors, e.g., the depth and width of excavation, wall length, preloads of struts, and the thickness of soft deposits, on the performance of diaphragm walls.

The second paper is by Dazhi Wen on the Development of Reinforced Concrete Segmental Lining Design for MRT Bored Tunnels in Singapore: Reinforced concrete segments are commonly used as tunnel linings for bored tunnels constructed by tunnel boring machines (TBM). This paper describes the development and evolution of the segmental lining design from the Phases I/II of the Singapore Mass Rapid Transit (MRT) construction in the 1980s to the current design for the MRT lines under construction. The topics include the general arrangement of the segmental linings, structural design requirements, durability requirements, fire resistance and selection of waterproofing materials of the linings. The design and construction of bored tunnels in close proximity is presented with the experience gained in the past projects. Fire tests conducted by the Land Transport Authority are also presented. The rational, experience and challenges of adopting steel fibre reinforced concrete segments in recent MRT projects are discussed in the paper. The paper also presents in detail the experience gained in Singapore MRT projects in selecting the gaskets for waterproofing of the joints between segments to achieve the durability requirements for the bored tunnels.

In the third paper, Jeyatharan Kumarasamy described the influence of Geology and its Impact on the Construction of Singapore MRT Circle Line: The Circle Line (CCL) is a fully underground railway line in Singapore connecting the inner suburban areas of the city. It is 39.5 km long with 34 stations and built in six separate packages. Site investigations comprising boreholes, CPTs and geophysical surveys for the project were carried out in various phases to reveal ground conditions along the route in order to determine the most appropriate construction methods. Extensive field and laboratory testing were also carried out to establish geotechnical design parameters. This paper summarises geological conditions encountered along the CCL route and highlights the effect of geology on selected construction methods.

In their paper (fourth one) K.H. Goh and Y. Zhang discussed the issues related to Constructing the cut-and-cover tunnels and bored tunnels of the Singapore Downtown Line: The Downtown Line (DTL) is a major MRT line under construction after the completion of the Circle Line in Singapore. This paper discusses the ground conditions for the DTL and how it influenced the selection of the support systems adopted for the excavation for the stations which are constructed using cut-and-cover method, and also the selection of tunnel boring machines for the bored tunnels. The key features of the temporary support systems were presented together with their performance in terms of ground movements and ground water table drawdown. Issues encountered during the excavation, in particular for DTL Stage 2 in the soils and rocks of the Bukit Timah Granite Formation was also presented in the paper and the effectiveness of various measures implemented will be discussed based on the experience and observations during the construction. The key features and

parameters of all the earth pressure balanced and slurry TBMs used in different DTL contracts were also presented and compared.

The fifth paper is on Bored tunnelling directly below buildings in Singapore Downtown Line by K.H Goh et al: One of the specific challenges faced in undertaking underground infrastructure developments is the construction of bored tunnels directly below buildings. This paper reports the experiences of bored tunnelling directly below several buildings in the recently implemented Downtown Line project, including case studies with details such as the structural system and foundation details of the buildings, ground condition, geometry and clearance between the building foundation and the tunnelling works, as well as instrumentation monitoring results of ground and building settlement during tunnelling. It is hoped that these cases could be used as references in the design of future bored tunnelling works; to give greater confidence that tunnelling directly below buildings can be carried out without affecting the buildings so long as appropriate tunnelling controls are taken to mitigate ground deformation issues.

In the sixth paper, Charles Im et al presented the Application of Gravity Survey in Urbanized City Environment: Subsurface information and geotechnical data are required during the planning, development and design stages of all construction projects particularly where major components are supported on or in the earth and underlying rock. An understanding of the basic site geology is also necessary for the proper planning of the ground investigation works. Consequently, the geological features that will affect the design and construction of the project must be investigated and evaluated as much as possible within the allowable project timeframe to ensure successful implementation of the project. This paper presents an overview of the authors' experiences in using Gravity Survey, as a reconnaissance ground investigation method to identify areas of enhanced ground risks, in the complex variable and unpredictable Kuala Lumpur Karstic Limestone formation during the underground reference design stage of the Klang Valley Mass Rapid Transit Line 2 (SSP Line) in Kuala Lumpur, Malaysia. This paper also presents some lessons learnt of the past in the region, and what were the specific measures that had been strictly implemented on this occasion to ensure quality results can be derived from the Gravity Survey within the urbanized city environment and meet the objectives of the survey.

M. Kawasaki et al are the authors of the seventh paper on Water Sealing by Wire Brush with Grease for Pneumatic Caisson Method at Great Depth Underground: Pneumatic caisson method can be widely applied to various ground but suffers from a limitation on the applicable depth due to the work under high atmospheric pressure. To overcome the problem, the pneumatic caisson method employing an unmanned excavation method with helium mixed gas has been developed. However, the new technology of the pneumatic caisson method will be required to construct a vertical shaft for urban tunnels at great depth underground space. Therefore, applying water-sealing technique at shield tail to friction cut space around pneumatic caisson wall, a method to reduce atmospheric pressure in a working chamber at the ground with low permeability has been proposed. This research carried out the element tests to examine the water-sealing performance of the proposed method, and discussed the influence of some properties on water-sealing performance and its mechanism. As a result, it was confirmed that the proposed method can keep the grease pressure of 1 MPa for one hour.

The eighth paper by N. Som and is entitled Geotechnical Challenges of Kolkata Metro Construction: The paper gives an account of the Kolkata Metro construction which included the first underground railway for mass rapid transit system of an Indian city. Construction was started in 1975 and the first line of the metro covering a length of 17 km was opened in 1984. Thereafter construction had been taken up in phases. Currently Kolkata metro construction includes an ambitious package of 140 km of underground, at grade and viaduct stretches. Construction has to be done in very difficult condition through congested urban areas which includes a tunnel below the Ganga river. Resource crunch and construction through heavily built-up urban land extended the period of construction but modern design techniques and field instrumentation have helped to ensure high quality work in densely populated urban centre.

In the ninth paper, Gerardo Agustin Pittaro deals with the use of pressure relief wells to optimize ground improvement layer thickness in deep excavations: Deep excavations in soft ground often need stabilization with ground improvement (GI). One of the methods to improve the ground is to use Jet Grouting Piles (JGP)

or Deep Soil Mixing (DSM). JGP and DSM are achieved by mixing the soil with cement and water, generating a structure that performs well under compression forces but not under tension forces. These ground improvement blocks provide larger passive resistance thereby reducing wall displacements. Due to the above mentioned one of the necessary requirements for successful design is that no tension forces are allowed in any zone of the ground improvement block. This paper discussed how pressure relief wells inside the excavation are used in order to decrease the tension strains in the ground improvement block. In order to demonstrate this, 2D numerical analyses were performed.

C. Veeresh and K.H. Goh in the tenth paper discussed about Bukit Timah Granite Formation - Engineering Properties and Construction Challenges: The Bukit Timah Granite Formation is one of the oldest geological formations in Singapore and is found mostly in the central and northern parts of Singapore. A major section of Singapore's underground metro construction passes through the Bukit Timah formation soils, and extensive field and laboratory testing has been carried out on the rock samples. Uniaxial Compressive Strength (UCS) tests have been carried out on hundreds of samples, test results have shown wide variation in the strength and the maximum strength is found to be much higher compared to the previously published data. This paper presents a review of UCS strength of the Bukit Timah Formation, Point Load index tests and correlations which were developed for site specific locations. This paper also reviews the abrasivity of Bukit Timah Granite and factors affecting it. Influence of UCS and other factors on the drilling, coring and excavation rates in Bukit Timah Granite are also presented.

In the eleventh paper and the last one assembled by the guest editors, L.J. Endicott presents the experiences of 41 years of Mass Transit Underground Railways: In 1975 many cities in Southeast Asia were becoming congested and few had underground railways. Now several cities have underground railway systems comprising several lines and many stations, some extend above ground. Currently underground railways are being built or are being extended in many cities in Southeast Asia. Construction projects are often large including several sections of tunnels and stations in one contract. This paper reflects on the early days of pioneering and on some of the changes that have taken place in the planning, design, and construction of underground Mass Transit Systems during the last 41 years.

The twelfth paper as described by by T. N. Huynh, H.V. Pham, M. Sugimoto, Y. Tanaka, H. Ohta and K. Yasui on the Simulation of H&V shield behaviour at sharp curve by kinematic shield model. The paper discusses the restriction of underground space use and the horizontal and vertical variation shield method (H&V shield) was innovated, of which the cross section is changed from horizontal multi-circular shape to vertical one or vice versa. However, this method has never been applied in practice. Therefore, this study aims to examine the H&V shield control method, using the developed the kinematic shield model for H&V shield. As a result, the following were found: 1) the calculated shield behaviour has an overall good agreement with the planned one; 2) the ground displacement is a predominant factor affecting shield behaviour; and 3) the proposed model can simulate the H&V shield behaviour reasonably.

The thirteenth paper (also contributed direct to the in-house editors) by Badee Alshameri, Aziman Madun and Ismail Bakar is the first of the contributed papers edited by San Shyan Lin on Comparison of the Effect of Fine Content and Density towards the Shear Strength Parameters : The improvement of soil strength is very important in the engineering design for the civil and geotechnical projects. However, this improvement can be achieved by improving the shear strength parameters of soil (i.e. shear strength, friction angle and cohesion) by using different techniques (e.g. densify the soil and change the soil composition). This paper will compare between the effects of density and fine content towards the shear strength parameters. Numerous soil samples (i.e. 99 samples) from six soil mixtures of sand-kaolin mixtures were compacted and subjected to direct shear box test to evaluate the effect of density and fine content. The results showed some discordant effects between the density and fine content. While the cohesion increased by the increment of the fine content, it decreased by the increment of the density. However, both of shear strength and friction angle increased to the highest value with the increment of the fine content and density then by further increment in the fine content and density, the shear strength and friction decreased where this behaviour can be explained through the inter-granular void ratio issue. On the other side, even the results showed interface between the effect of density

and fine content, but the fine content has more significant effect in the shear strength parameters and also in the soil density value itself.

The fourteenth Paper (also contributed direct to the in-house editors) by Xiao-long Zhou et al is on Shaft Resistances of Jacked Open-ended PHC Pipe Piles: The shaft resistance of open-ended pipe piles during installation and static loading test plays an important role in the design of pile foundation. One open-ended Pre-stressed High-strength Concrete (PHC) pile instrumented with sensors was jacked to investigate the performance of shaft resistance during installation and loading test. Test results indicated that the shaft resistances gradually transferred along depth during installation, and the magnitude is closely related to soil properties. The shaft resistance at the same depth decrease with jacked cycles. After five jacked cycles, the shaft resistances in sand silt at 6 m depth decreased about 58.8%. The decrement of silty clay at 10 m depth was about 12.1% after three jacked cycles. In the loading test, the shaft resistance of test pile were gradually mobilized from up to down.

P.R. Stott and E. Theron in the fifteenth paper (also contributed direct to the in-house editors) is on the Estimation of Shrink/Swell Potential and Variability of Clays by Small-Scale Suction Tests: The relationship between suction and water content gives crucial information about a soil. Small projects like economic housing do not warrant the time and cost of determining the full soil water suction curve. A considerable range of soil suctions can easily be achieved within a reasonably short time by using small samples, simple suction control and a high precision balance. It appears that in this way it may be possible to estimate heave potential and variability of soil properties at reasonable cost in an acceptable time. Variability assessment appears to offer significant potential for improving the reliability of foundation design on shrink/swell soils.

The sixteenth paper (also contributed direct to the in-house editors) by M. R. Selamat et al is on Pullout Tests on Strips with Anchorage Elements under Low Stresses: The lack of pullout capacity of reinforcement strips often compromised the finishing quality of the mechanically stabilized earth (MSE) structure. In this research, three strips were each attached with 6 anchorage elements of 1cm, 2cm, and 3cm deep respectively in order to enhance the pullout capacities, while another strip was plain. Each strip was subjected to pullout tests under low normal stresses ranging from 1.61kPa to 13.20kPa to simulate shallow embedment in the field. Under the low normal stress of 1.61kPa, the pullout capacities of strips with anchorage elements were enhanced up to 366% of the plain strip capacity; under the higher normal stress of 13.2kPa however, the pullout capacity enhancements were only up to 163% of the plain strip capacity. The results indicate the merit of attaching anchorage elements to strips under shallow overburden in a MSE structure and the significant increase in pullout capacity achievable by such strips.

The last paper of this Issue is seventeenth (also contributed direct to the in-house editors) by Li Changhong, Zhou Xiaolong, Zhang Long,Wei Xiaoming and Li Wanling on Numerical Simulation Analysis and In-situ Monitoring of Long and Narrow Deep Foundation Pit. The authors studied the characteristics of long and narrow deep foundation pit. The displacement distribution of X-axis with different length-width ratios of 1:1, 2:1 and 3:1 were analyzed and then the displacement distribution of Y-axis at the slope bottom and the displacement distribution of Z-axis at the foundation bottom were studied. The different displacement distribution law of pile-anchor support and soil nailing wall support were analyzed in different excavation processes considering in-situ supporting schemes, and the different supporting effects of the two supporting structures were presented on the stability of foundation pit slope. By comparing the monitoring values at the 32 in-situ positions, the numerical simulation result was basically identical with the monitored data, on average 3mm higher than the measured value. By using MIDAS software, the excavation and supporting process of the foundation pit could be simulated, and it can provide guidance for the construction of long and narrow deep foundation pit and adjust the monitoring period appropriately.

Editors:
Kok Hun Goh
Jeyatharan Kumarasamy
Richard Hwang
San Shyan Lin

ACKNOWLEDGEMENT

Seventeen papers are contained in this issue. Twelve of them are assembled by the Guest Editors and another five contributed papers directly to the in-house editors. No doubt the material contained herein would be most valuable to our profession. The editors have adequately described the contributions in the preface. They are to be congratulated for these contributions.

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

Geotechnical Engineering Journal of the SEAGS & AGSSEA Vol. **48 No. 2 June 2017 ISSN** 0046-5828

GEOTECHNICAL ENGINEERING

June 2017: Mass Transit Projects & Contributed papers

Edited by
Kok Hun Goh, Jeyatharan Kumarasamy, Richard Hwang & San Shyan Lin

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Geotechnical Engineering Journal of the SEAGS & AGSSEA

Vol. 48 No. 3 September 2017

ISSN 0046-5828

GEOTECHNICAL ENGINEERING

Journal of the

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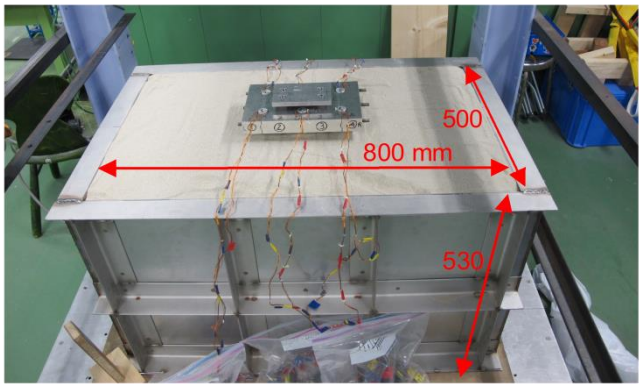

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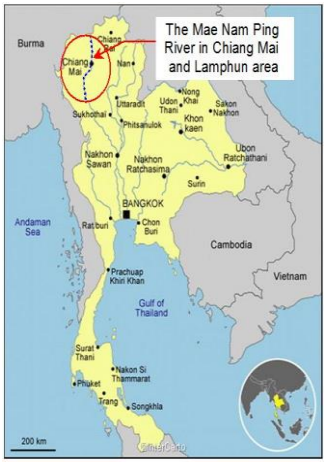

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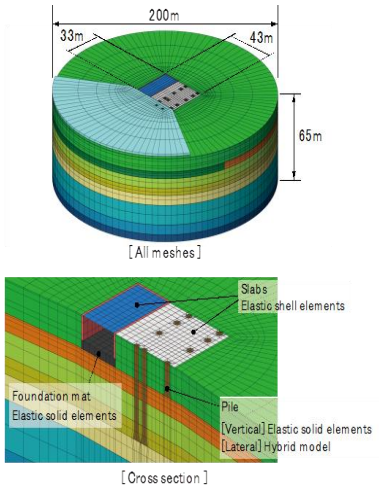

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GEOTECHNICAL ENGINEERING

September 2017: Deep Foundations

Edited by: Tatsunori Matsumoto, Der Wen Chang & San Shyan Lin

Tatsunori Matsumoto

Prof. Matsumoto is now with Kanazawa University in Japan for nearly 37 years. He was educated at the Kanazawa University and received his Doctoral Degree from Kyoto University for his work on steel pipe piles in 1989. He has extensive research and practical experience on piled foundations and piled raft foundations. Prof. Matsumoto has a Shake Table Facility for the study of dynamic and earthquake type of behaviour of piled foundations. He has also worked on the centrifuge with pile groups and piled raft foundations in collaboration with Taisei Corporation. Prof. Matsumoto also has wide experience in the seismic design of raft and piled raft foundations. Prof. Matsumoto is one of the authors of the computer software PRAB—Piled Raft Analysis with Batter Piles. With this software piled raft foundation can be analyzed with vertical and horizontal loads as well as moment.

Der Wen Chang

Prof. Der-Wen Chang has been the Geotechnical faculty member at The Department of Civil Engineering of Tamkang University (TKU), Taipei, Taiwan for over 25 years. He received Ph.D. in Civil Engineering at The University of Texas at Austin in 1991 and MS in Civil Engineering at Michigan State University in 1987. Prof. Chang has supervised the research work of over 70 Master Thesis and 3 Ph.D. Thesis at TKU, and published more than 200 articles as the Journal, Conf. papers and reports. Nearly all his research studies are related to numerical modeling and dynamic analyses for the geotechnical structures. His research experiences include NDT methods on pavements, seismic behaviors of the pile foundation, constitutive modeling of the soils, and recent study on the performance based design for the earth structures. Prof. Chang is also the visiting Professor at University of Washington at Seattle, US in 2008 and LN Gumilyov Eurasian National University at Astana, Kazakhstan for research studies in 2010 and 2011. Other than the research works, Prof. Chang devotes himself a great deal to serve the communities. He involves heavily and indeed shows his good performance in the public works related to education and constructions. Prof. Chang is currently the Executive Board member of Chinese Taipei Geotechnical Society, GC member at SEAGS and Editorial Panel for SEAGS/AGSSEA J. of Geotechnical Engineering, and TC212/TC305/ATC18 member at ISSMGE. He is also the Chairman of Conference Committee at 16ARC which is to be held in Taipei, Taiwan in October, 2019.

San Shyan Lin

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

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

GEOTECHNICAL ENGINEERING

PREFACE

There are 17 papers in this Issue; the first twelve are papers edited by the Guest Editors: Tatsunori Matsumoto, Der-Wen Chang and San-Shyan Lin; additionally there are five contributed papers are processed by our in-house editors.

The first paper is by K. Ng and T. Sullivan on challenges and recommendations for steel H-piles driven in soft rock: The capacity of a pile driven in soft rock depends on soil confinement along the pile and rock at its toe; these are rarely known during design. This design challenge often leads to a large discrepancy between estimated and measured resistances. Results of six bridge projects completed in Wyoming, USA, are presented to highlight the challenges pertaining to present design and construction practices of driven piles in rock. The results show that static analysis methods, dynamic analysis methods, and structural analyses yield inconsistent pile resistance estimations. A recommendation considering the structure-geomaterial interaction is proposed to improve the design and construction of steel H-piles driven in soft rock.

The second paper is by Anh-Tuan Vu, Tatsunori Matsumoto, Shun-ichi Kobayashi and Shinya Shimono on Experimental study on pile foundations having batter piles
subjected to combination of vertical and horizontal loading at 1-g field: in the paper, the behaviours and resistance mechanisms of pile foundations having batter piles were investigated through a series of vertical load tests and combination load tests on model foundations in dry sand ground at 1-g field. Pile foundation models consisting of 3 piles and 6 piles, with or without batter piles, were used in the experiments. The model pile was close-ended pipe with a length of 255 mm and an outer diameter of 20 mm. Dry silica sand having a relative density, Dr, of about 82% was used for the model ground. The results indicate that the piled raft having batter piles is the most effective to increase the resistances (in both vertical and horizontal directions) and reduce the inclination.

In the third paper, T. Tikanta, T. Matsumoto, A. T. Vu, S. Kobayashi, S. Shimono and C. Bamrungwong conduct experiments on a reinforcement method using sheet pile wall for bridge pile foundations subjected to pile embedment reduction and numerical validation. Due to the riverbed soil excavation for the utilization in construction works for many years, the level of riverbed of the Mae Nam Ping River has been considerably decreased, resulting in reduction of embedment lengths of piles for many bridge foundations. Erosion was not a cause of the lowering of the riverbed. Reductions of bearing capacity due to the lowering of riverbed soil is the main cause of bridge pile foundation settlements or collapses at present. In order to prevent the damages of existing bridge pile foundations caused by the riverbed soil excavation, a reinforcement method using sheet piles called “Sheet Pile Wall (SPW) reinforcement” is proposed. The experimental results show that the proposed SPW reinforcement method is very efficient and promising. Numerical simulation of an experiment using FEM was also carried out to get more insight into the mechanism of the SPW method and validate the proposed SPW method.

In their paper (fourth one) San-Shyan Lin, Yun-Chih Chiang, Xin-Hua Lin, Hsing-Yu Wang, and Sung-Shan Hsiao carry our numerical studies on performance of offshore wind turbine composite suction pile in sand subjected to combined loading. Numerical analysis on the performance of the proposed suction pile with enlarged lid size subjected to combined lateral and axial loading is presented in the paper. The numerical model is firstly validated by comparison with other numerical study results. The parametric analysis results prove a suction pile with enlarged lid size has better performance than a normal suction pile on both the overall bearing capacity and the stability of the foundation.

The fifth paper is on Consideration of Effects of Pile Group Interaction in Piled Raft System Based on Field Monitoring and Single Pile Load Tests by K. Yamashita, S. Wakai1, J. Hamada and T. Tanikawa. In the paper, the effects of pile group interaction were investigated based on the results of two monitoring cases of piled raft foundations and single pile load tests in soft ground. Based on the investigation, it was found that the modified load-settlement data of the monitored piles were generally consistent with the static load-settlement curve of a single pile. Therefore, no significant effects of pile group interaction on settlement were found. In such cases as pile groups with large spacing, single pile load test data can be more useful in the settlement prediction of piled rafts and pile groups. In addition, it was found that the pile head stiffness of the equivalent static load-settlement curve derived from the rapid load testing in clay soils using the UPM was considerably large compared to the stiffness of the static load test curve, as pointed out by previous studies.

In the sixth paper, In-situ Full Scale Load Tests and Reliability Evaluation of Bearing Capacity for Nodular Cast-in-place Concrete Pile is studied by K. Watanabe, A. Mitsumori, H. Nishioka and M. Koda. This paper firstly summarizes the in-situ full scale load tests, and then describes the results of standard bearing capacity based on the data from the in situ full-scale load tests, finally mentions the estimation of ground resistance coefficient for nodular cast-in-place concrete piles.

The seventh paper by K. Watanabe, T. Yamamoto and T. Sudo is titled Development of Steel Pipe Pile Combined with Ground Improvement in Narrow Spaces. Since pile construction in narrow spaces is constrained by the site and process, in this paper, a construction method combining steel pipe piles with ground improvement using a mechanical agitator (e-column construction method®) was developed. This paper briefly summarizes the construction method, presents the static load tests and rapid load tests, and discusses the results of load tests. The results of the loading tests suggest that the bearing capacity can be evaluated by using the undrained shear strength and SPT N-value. Also, a simplified rapid loading test can be applied to validating the bearing capacity at a construction site. For the joint of the steel pipe piles, the maximum tensile resistance obtained from the experiment was larger than that obtained from the calculation formula.

In the subsequent paper eight in the series K. Watanabe, N. Suzuki and M. Sahara deal with Design and Analysis of Composite Foundation for High-rise Buildings. This paper shows two design cases of composite foundations for high-rise buildings. These two foundations were designed by considering the effect of deformation on the results of a static FEM analysis. The slab settlement was measured upon completion of construction. It was con-firmed that composite foundations deform within a presupposed range.

Hung-Jiun Liao, Chin-Lung Chiu, Chung-Kuang Chien, Yi-En Tang and Heng-Chih Cheng in the ninth paper deal with Pervious Material Made from Landslide Debris for Road Base Construction. This paper introduces an on-site mixing method to prepare pervious-CLSM (controlled low strength material) from the landslide debris by mixing it with proper amount of cement and water. Through the mixing process, the fine soils in the debris will flocculate to a sizable particles and/or stick to the surface of aggregates. As a result, the fines content of the debris can be eliminated and a pervious-CLSM is made. Through the binding effect of cement, the pervious-CLSM can also have moderate strength to maintain the stability of filled embankment and to sustain the traffic load as well. Together with geo-grid, a wrap-faced reinforced embankment as the road base can be constructed quickly using the site prepared CLSM as well as a backhoe machine and hand tools.

The tenth paper is by E. Heins, K.-F. Seitz, A. Chmelnizkij, M. Milatz and J. Grabe on Advances in numerical modelling of different ground improvement techniques. A lot of successful scientific research is conducted on piles and piling using various numerical methods. Therefore, it is assumed that numerical models can be used to improve ground improvement methods. In this contribution, different ground improvement techniques and numerical models to simulate the influence of these techniques on the surrounding soil are presented. Furthermore, optimization methods and potentials of ground improvement techniques are shown.

Ashutosh Kumar and Deepankar Choudhury are the authors of the eleventh paper on Load sharing mechanism of Combined Pile-Raft Foundation (CPRF) under seismic loads. In the present work, the load sharing mechanism under seismic loads for fully hinged (H) and fully rigid (R) connected Combined Pile-Raft Foundation (CPRF) have been studied by using three-dimensional finite element based geotechnical software. Results of the present analyses show that connection rigidity had little influence on vertical settlement of CPRF but had pronounced response on the load sharing by foundation components. In the purview of seismic loading, lateral stiffness played a pivotal role in deciding the load-settlement, lateral displacement, bending moment in piles and inclination response of CPRF. The load sharing by foundation components is governed by mobilization of lateral displacement.

The 12th paper and the last one as assembled by the guest editors is Deflection Behaviour of GFRP Bar Reinforced Concrete Passive Bored Pile in Deep Excavation Construction by J. L. Zhou, E. Oh, X. Zhang, M. Bolton, H. Y. Qin and L. Zhang. This paper describes the investigation of a glass fibre reinforced polymer bar (GFRP bar) as a replacement for a traditional steel bar reinforcement in bored concrete piles with specific application to deep excavation construction. The deflection behaviours of GFRP piles during the installation of one concrete and two steel supports were provided. It is concluded that, based on the difference between the total accumulated deflection of each pile, the GFRP bar reinforced concrete piles can resist the lateral loading and can provide an alternative to traditionally reinforced concrete piles used in shield construction.

The 13th paper by describe by Byron Mawer, Denis Kalumba and Charles Warren-Codrington is the first of the contributed papers edited by San Shyan Lin on Loading and Dynamic Response Considerations for the Design of Wind Turbine Foundations on South African Soils. The discussion of this paper was centered on the sources of loading that wind turbines experience and the consequences of this on the geotechnical design of gravity footings. Rotational stiffness of the foundation was shown to have an important effect on the dynamic response of the wind turbine tower, and thus, on the assumptions surrounding the calculation of the natural frequency of the global system. Soil stiffness effects on natural frequency assumptions were found to be more critical than the minimum stiffness requirements applied by design guidelines and had a notable effect on dynamic amplification for an undamped system.

The 14th paper (also contributed direct to the in-house editors) by Mounir BOUASSIDA, Mnaouar KLAI, Seifeddine TABCHOUCHE and Mekki MELLAS on Comparison of Numerical Analyses of Behaviour of Column-Reinforced Foundations. This paper studies the prediction of behaviour of foundations resting on a soil reinforced by sand and stone columns. A Tunisian case history of oil tank is investigated. By adopting the Mohr-Coulomb failure criterion for columns material and the hardening soil model for soft clay, the evolution of long term settlement predicted by Plaxis code showed the acceleration of the consolidation of the compressible soft clay due to the enhanced drainage property of column material.

P. Pizette and N-E. Abriak in the 15th paper (also contributed direct to the in-house editors) is on Particle image velocimetry analysis on the sinking of shallow foundation in 2D. This paper focuses on the development of punching device dedicated to study the failure of 2D analogue soil. In order to follow the kinematic behaviors of soil, Particle Image Velocimetry (PIV) analysis has been developed and tested in the case of the shallow foundations. The results show that the field of the soil displacement under the foundation can be followed via the PIV method. In particular, the image analysis results are qualitatively in good agreement with the Prandlt scheme.

The 16th paper of this Issue (also contributed direct to the in-house editors) is by B. T. T. Nguyen1, T. Takeyama2 and M. Kitazume on Attempt of Simple Calculation on studying Failure mechanism of DM Columns. A simple calculation, based on limit equilibrium method, was performed to evaluate the failure pattern of deep mixing (DM) columns, used to reinforce an embankment slope. In this study, a trial of limit equilibrium method to access the failure mode of the columns is focused with an overall mechanism. As a result, while the calculation can simply predict the failure pattern of the DM columns, a parametric study was also performed to evaluate the effect of several improvement factors.

The last paper of this Issue, the 17th (also contributed direct to the in-house editors) is Microzonation of liquefaction hazard using liquefaction index in Babol City by A. Janalizadechoobbasti, M. Naghizadeh rokni, and R. Charaty. In this paper, the zoning map of Babol liquefaction risk is provided. In this regard, a study was conducted on the soils in Babol and after examining different areas of the city, laboratory results and field studies of more than 50 boreholes in different areas with a depth of 20 m were analyzed for finding liquefaction and non-liquefaction segments. In this study, different approaches were used including Seed, Iwasaki, Haeri and Yasrebi, Chin & Zhang and Sewmez & Gocojlou procedures and finally, a computer program was written for examining and providing microzoning map of Babol liquefaction risk.

Editors:
Tatsunori Matsumoto
Der Wen Chang
San Shyan Lin

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Seventeen papers are contained in this issue. Twelve of them are assembled by the Guest Editors and another four contributed papers by the in-house editors. No doubt the material contained herein would be most valuable to our profession. The editors have adequately described the contributions in the preface. They are to be congratulated for these contributions.

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Geotechnical Engineering Journal of the SEAGS & AGSSEA Vol. **48 No. 3 September 2017 ISSN** 0046-5828

GEOTECHNICAL ENGINEERING

September 2017: Deep Foundations

Edited by
Tatsunori Matsumoto, Der Wen Chang & San Shyan Lin

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Geotechnical Engineering Journal of the SEAGS & AGSSEA

Vol. 48 No. 4 December 2017

ISSN 0046-5828

GEOTECHNICAL ENGINEERING

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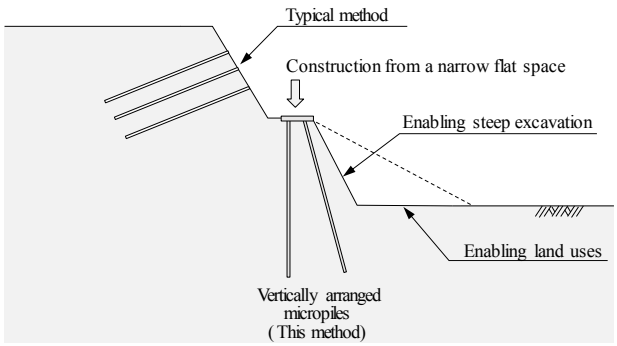

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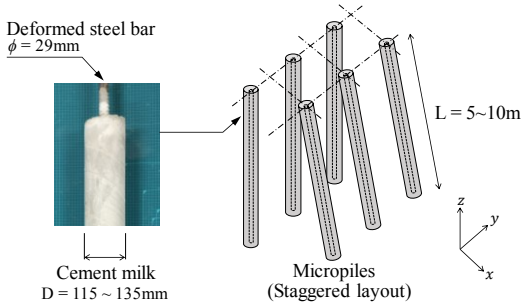
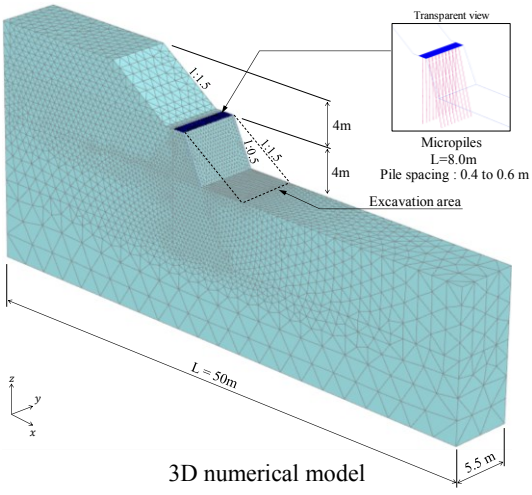


Overview of micropiles



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PREFACE

December 2017 Issue

This Issue is in two parts; Part 1 papers edited by Prof Akira Murakami as Guest Editor and Part 2 contributed papers directly edited by In-house Editors and Prof Mounir Bouassida

The first seven papers in the Issue are edited by Prof Akira Murakami as the Guest Editor and the subsequent papers are direct contributed ones; quite a few papers were acquired by Prof Mounir of papers from African continent.

The first paper is on Modelling the Effects of Static Shear on the Undrained Cyclic Torsional Simple Shear Behaviour of Liquefiable Sand by Gabriele Chiaro, L.I. Nalin De Silva and Junichi Koseki: Spanning from purely theoretical standpoint to practical applications, there is a particular interest to enhance understanding of the effects of static shear on the cyclic behavior of soil elements underneath sloped ground. To address this issue, two subsequent steps were undertaken in this study. First, a systematic laboratory investigation was carried out on Toyoura sand specimens subjected to various levels of combined static and cyclic shear stresses. Then, a new state-dependent cyclic model was developed. Since experimental findings have been exhaustively reported elsewhere, in this paper they are only briefly recalled for the benefit of comprehensiveness. Instead, the new model is presented in details and its performance is verified by simulating undrained cyclic torsional simple shear tests carried out on Toyoura sand specimens. Essentially, the model is built on an extended general stress-strain hyperbolic equation approach, in which the void ratio and stress level dependency upon non-linear stress-strain response of sand is incorporated. Besides, a novel empirical stress-dilatancy relationship is used to account for the effect of density on the stress ratio as well as to model the excess pore water pressure generation in undrained shear conditions as the mirror effect of volumetric change in drained shear conditions.

The second paper by A. Kamura, J. Kim, T. Kawai, M. Kazama, N. Hikita and S. Konishi is on Numerical Study on the Design of Reinforced Soil by Vertical Micropiles. The mechanical behaviour of the reinforced soil by vertical micropiles was considered using the three-dimensional finite element analysis. To make effective use of space around the slope, soil needs to be reinforced using micropiles placed in a small area. The main objective of this investigation was to evaluate the mechanical influence of various micropile arrangements and to determine the effects of pile spacing for design purposes. Numerical simulations of three cases using different pile angles indicated the amount of slope displacement and the values of the sectional force of the micropiles differed significantly. Among the three cases, the maximum slope displacement was 1.7 times the minimum value. Finally, numerical simulations of three cases using different pile spacing was carried out to clarify the effects of pile spacing on the amount of slope displacement and the sectional force of the micropiles.

In the third paper Soil-water Coupled Analysis of Pore Water Pressure Dissipation in Performance Design—Examinations of Effectiveness in Reclaimed Ground is studied by Toshihiro Nonaka, Shotaro Yamada, and Toshihiro Noda: Japan has a large number of reclaimed regions unimproved against liquefaction and countermeasures in such regions are necessary to prepare for a great earthquake. A new macro-element method has been proposed that involves applying the soil-water-coupled finite deformation analysis code ***GEOASIA*** with an inertial term, and a numerical-analysis technique has been designed that quantitatively evaluates the improvement effect of the pore water pressure dissipation method (PWPDM). In this study, PWPDM effectiveness was examined for a reclaimed ground using the proposed method. Detailed examinations were conducted with the intention of developing a more advanced performance design, without being limited to the concept of the current design code. The main findings are as follows: 1) the proposed analysis code enables quantitative evaluation of the improved effectiveness of PWPDM in a reclaimed ground; 2) more advanced PWPDM designs are possible by not only suppressing the maximum

excess pore water pressure to the permissible range of the current design code, but also evaluating the ground deformation adequately; and 3) the new macro-element method, capable of reproducing the phenomenon of well resistance, can evaluate the reduction in the improvement effect because of the degradation of drainage capability, thus making it useful for maintenance purposes such as drain clogging.

In their paper (fourth one), Y. Fukumoto and S. Ohtsuka made Comparison of Sheared Granular soils: Same Void Ratio but Considerably Different Fabric: This paper reports a comparison of two types of sheared granular soil specimens, with almost the same void ratios but considerably different fabric, using the discrete element method in two dimensions. The specimens are prepared by applying two different methods of particle generation; one specimen is generated by placing the particles geometrically, while the other specimen is generated by placing the particles randomly. Then, computational direct shear tests are conducted in order to compare the yielding behaviours of the two specimens. The obtained bulk shear responses show different trends, even though the values for the void ratio at the initial state are almost the same. Toward the critical state, however, the initial differences in the stress state and the granular fabric gradually disappear and eventually reach almost the same state. The results reveal that not only macroscopic quantities, but also the contact force distribution and the angular variation in contact forces, have a unique critical state. In particular, the angular distribution of contact angles inside the shear band is also found to have a unique critical state.

The fifth paper is on Coupled Analysis of Navier-Stokes and Darcy Flows by the Brinkman Equations by S. Arimoto, K**.** Fujisawa and A. Murakami: Simultaneous analysis of seepage flows in porous media and regular flows in fluid domains has a variety of applications to practical problems. The objective of this paper is to present a numerical method to simulate these two different flows simultaneously and continuously, and to investigate the influence of the Darcy flows in porous media on the Navier-Stokes flows in the fluid domain. To this end, the authors have employed the Darcy-Brinkman equations, which include the Navier-Stokes equations and can approximately describe Darcy flows by changing the values of porosity and hydraulic conductivity. The solutions of the Darcy-Brinkman equations are affected by two dimensionless quantity, i.e., the Reynolds number, Re and the Darcy number, Da. After the procedures to provide stable solutions of the governing equations are explained, this paper considers the two types of problems involving Navier-Stokes/Darcy coupled flows and the influence of the two dimensionless parameters on the solutions are investigated. One is the backward-facing step flow with a porous step, and the other is the preferential flows in porous media. The numerical results have shown that the permeability of the porous step slightly affects the reattachment of the flow in the former problem, and that the shape of the void or cavity in porous media changes the structure of the flow in it and the Darcy number changes the flux into the fluid domain in the latter problem.

In the sixth paper, Y. Kurimoto, Y. L. Xiong, S. Kageyama and F. Zhang presented Numerical Investigation on Mechanical Behaviour of Natural Barrier in Geological Repository of High-Level Radioactive Waste. It is commonly known that geological repository is regarded as the most practical way of permanent disposal of high-level radioactive waste (HLW). Yet, there are some engineering problems needed to be solved before its practical application. In geological repository, one of the most important factors is the thermo-hydraulic-mechanical (THM) behaviour of natural barrier. The aim of this paper is to investigate the influence of temperature on the deformation and the strength of host rocks, such as the soft sedimentary rock, with some element tests and the numerical simulations with a program of FEM named as ***SOFT*** based on a thermo-elasto-viscoplastic constitutive model.

Trihanyndio Rendy Satrya, Ria Asih Aryani Soemitro, Toshifumi Mukunoki and Indarto are the authors of the seventh paper and the last one assembled by the guest editor on Change of Soil Properties in the Bengawan Solo River Embankment due to Drying–Wetting Cycles. This paper studies the behaviour of Bengawan Solo River embankment soil properties for both in-situ and laboratory conditions. In the laboratory, series of cyclic drying and wetting tests were carried out to clarify the changes of in-situ soil properties over time since the soil had been initially compacted. Maximum dry density from Standard Proctor test was applied as initial compacted condition. Three cycles of drying and wetting were used to represent three cycles of dry and rainy seasons. The in-situ soil investigation was carried out during seasons. The results show that the investigated in-situ soil properties were in good agreement with the laboratory test

results at the 2nd and 3rd cycles. It denotes that these numbers of cycles are required to achieve the similar condition as in-situ soil. In addition, by observing the rate of change in soil properties, it was possible to trace back the construction time of the river embankment.

The eighth paper and the rest are from direct contribution. The eighth paper is on Soft Ground Improvement at the Rampal Coal Based Power Plant Connecting Road Project in Bangladesh by Sudipta Chakraborty, Ripon Hore, Fahim Ahmed and M. A. Ansary. Preloading with vertical sand drain (VSD) is presented as a soil improvement method in this paper. The work is based on a real life road (4 lane and 2 slow moving lanes) construction project carried out in Rampal sub-district of Bagerhat, Khulna, Bangladesh. The construction sequences and the basic design example of VSD for embankment works on very soft clay soil are discussed in this paper. This paper presents soft ground improvement using VSD including VSD installation, preloading techniques, settlement and stability, design calculation, observational method and analysis of monitoring data. No extra load has been used; preloading has been carried out with the self-weight of road in combination with fill embankment. Soil treated with VSD, has resulted in improvement of soil settlement.

The ninth paper by Badee Alshameri , Aziman Madun and Ismail Bakar is entitled Assessment on the Effect of Fine Content and Moisture Content Towards Shear Strength**.** The shear strength τ, shear modulus G, friction angle $\emptyset$, and cohesion c are remarkable design parameters in the geotechnical and civil projects. These design parameters were affected by several factors. In this paper, the fine content and moisture content factors will be evaluated. Numerous compacted sand-kaolin samples were test through the direct shear box test (by using shear rate equals to 1 mm/min, the samples dimension equals to 100 × 100 mm) to assess the effect of these factors. The results show interface between both effects of fine content and moisture content towards the shear strength parameters. According to the results; (1) there is no significant effect on shear strength parameters at low portions of fine content FC and moisture content w, (2) at higher portion of FC and w, bot FC and w show different relationships with shear strength parameters, (3) both relative high shear rate and low applied stress lead to present high value of friction angle (4) compact the soil mixtures with same compaction effort and different fine and moisture content lead to change the soil structure and void ratio thus produce regressive relationship between the friction angle toward density.

Dipendra Gautam, Hemchandra Chaulagain, Hugo Rodrigues and Hem Raj Shahi in the tenth paper worked on Ground Response Based Preliminary Microzonation of Kathmandu Valley. This paper analyzes spatially selected 286 deep borehole logs reaching up to the bedrock are and the results are presented in terms of amplification factor, ground acceleration and predominant period. The peak ground acceleration (PGA) is estimated to be 0.10 and 0.50 g indicating strong influence of nonlinearity in particular areas of Kathmandu valley wherein de-amplification is observed. The peak spectral acceleration is found to be varying between 0.30 to 1.75 g for the study area and soil predominant period is estimated in the range of 0.7 to 5 sec. Preliminary microzonation maps for PGA and soil predominant period are prepared and presented in this paper. Comparisons and interpretations on the basis of 1934 and 2015 earthquakes are presented in terms of damage scenario.

In the eleventh paper, V. Oderah and D. Kalumba investigated on the Use of Sugarcane Bagasse for Soil Reinforcement in Geotechnical Applications. The global initiative of minimizing the generation of waste materials, and the reduction of the environmental footprint of industrial processes has impelled the innovation into their use in geotechnical applications. Use of these materials in this manner, especially as soil reinforcements, could help solve the drudgery and secondary snags of disposing of the materials. This study therefore aimed at investigating the effects of sugarcane bagasse reinforcement on selected South African soils as well as the drawbacks of environmental conditions on the composite formed. Different types of sugarcane bagasse were utilised in evaluating their effect on the shear strength characteristics of the composite. The results indicated a higher improvement in the angle of internal friction in finely grained soil compared to coarsely grained soil. Saturation of the composite in water insignificantly reduced the strength characteristics beyond 2 days. In addition, an increase in shear characteristics depended on fineness of the soil, bagasse type and content, and on the vertical load.

The twelfth paper as described by S. Daoud, I. Said, S. Ennour and M. Bouassida on Quasi-Static Numerical Modelling of an Ore Carrier Hold: The problems associated with ore carriers' incidents, have preoccupied international organizations and many research laboratories which have been mobilised to identify the causes and seek for the solutions. The cargo liquefaction is considered to be the major cause of ore carriers' capsizing. The final aim of this research is to establish a new test procedure for evaluating the shear strength of loaded ore in view of its liquefaction prevention. First, a brief review is presented about the possible origins of cargo instability and examines the stress distribution by means of a quasi-static numerical modelling. Second, an assessment of the shear ratio variation, in terms of the hold inclination is established. According to this analysis, at a 15° hold inclination, the maximum shear ratio is less than 0.2 in all pile areas except under the residual slopes and at the surface that are assumed to be the most vulnerable parts.

The thirteenth paper is on Shear Strength of an Expansive Overconsolidated Clay Treated with Hydraulic Binders by A. Mahamedi and M. Khemissa: This paper presents and analyzes the results of a series of identification, compaction and direct shear tests performed in accordance with the Algerian standards on an expansive overconsolidated clay treated with locally manufactured hydraulic binders (composed Portland cement and extinct lime). This clay comes from the urban site of Sidi-Hadjrès city (wilaya of M'sila, Algeria), where significant damages frequently appear in the road infrastructures, roadway systems and various networks and in civil and industrial light structures. Tests results show that the geotechnical parameters values deduced from these tests are concordant and confirm the shear strength improvement of this natural clay treated with cement or lime and compacted under the optimum Proctor conditions. However, contrary to its mineralogical characteristics which do not seem to be affected by the treatment, this expansive natural clay is characterized by as well drained as undrained shear strength sensitive to stabilizer content; the best performances are obtained for a treatment corresponding to 8% cement or lime content.

The fourteenth paper is on Numerical Modelling of Retaining Wall Resting on Expansive Soil by Bushra Suhale Al-Busoda , Safa Hussain Abid Awn, & Hassan Obaid Abbase : To model the behavior of expansive soil, it seems necessary to move towards elastoplastic models that have been used for different types of clays. Hardening soil model is chosen in this study. Retaining walls rested on expansive soils are subjected to uplift and lateral forces due to soil swelling. More importantly, the swelling in expansive soil tends to cause additional lateral pressure on wall that caused deformations and bending. Various pattern types of helical piles are used to reduce the vertical and lateral movement of retaining wall constructed on expansive soil. The backfill soil beyond retaining wall is affected by swelling of expansive soil that caused additional lateral earth pressure on the wall of retaining wall. This study showed that the use of inclined helical piles beside vertical helical piles under the base of retaining wall decreased vertical movement 94% and lateral movement 70% for ratio of length of helical pile to depth of expansive soil (L/H) equal to 3.2. In general, the presence of helical piles below retaining wall resisted and controlled the vertical movement but do not control lateral movement except the case of using inclined helical piles.

N. M. Alsanabani, T. O. AL-Refeai, and A. O. Alshenawy in the fifteenth paper is on Simplified Method for Designing Piled Raft Foundation in Sandy Soils: The main purpose of this study is to develop a simplified method for computing the load carried by piles, and settlement of piled raft based on the characteristics of an unpiled raft, pile group, and soil. These are important criteria for preliminary piled raft design. Based on the results obtained from finite element analysis, simplified formulas and curves are generated for different conditions of sand and different pile spacing. These formulas and curves contain the stiffness ratio and efficiency factor of the unpiled raft and pile groups. The results of the proposed method were validated using the Poulos–Davis–Randolph method.

The sixteenth paper by Ramkrishnan R., Karthik V., Mukund S. Unnithan, Kiran Balaji R., Athul Vinu M., Anju Venugopalan is on Stabilization of Seepage Induced Soil Mass Movements using Sand Drains: Rising groundwater levels increases the pore water pressure in the soil slopes, acting as a triggering factor for landslides. By installing sand drains (horizontal or vertical) along the slope, the groundwater level can be lowered below the critical level, reducing the pore water pressure and also the probability of slope failure significantly. In this study, laboratory-scale soil slopes of varying geometry were modelled in a tank and

constant inflow was provided to simulate groundwater flow. With and without loading, the critical phreatic levels for the various slopes were determined. Vertical sand drains were then installed along the slope and the tests were repeated for a fixed duration. It was found that the slopes did not fail and remained stable for a longer time period, even with increase of groundwater flow. Hence it was concluded that sand drains are a feasible slope stabilization technique even on slopes subjected to static loading.

The seventeenth paper is on Experimental Study on the Durability of Soil-Cement Columns in Coastal Areas by Pham Van Ngoc, Brett Turner, Jinsong Huang and Richard Kelly: Deep soil mixing is one of the most commonly used ground improvement techniques. With high sulphate content in soil and seawater, stabilized soil in coastal areas can deteriorate in strength due to sulphate attack. In this research, the degradation in strength of cement treated soil exposed to synthetic seawater is measured by uniaxial compression and needle penetration testing. Three exposure conditions, namely 100% seawater, 200% seawater and in sealed condition (control samples), were used to measure the deterioration level due to the effect of sulphate. In addition, the extent of the portlandite consumption was also measured by Thermo-gravimetric Analysis which reflects the calcium distribution in the soil-cement columns. The test results show that the strength deterioration occurs deeper and faster in higher seawater environments. Furthermore, when in contact with increasing sulphate concentration, the strength deterioration shows a close relation with calcium distribution.

The eighteenth paper is by Wei Xiaoming ,Li Changhong ,Zhou Xiaolong ,Hu Baowen & Li Wanling on The Change Laws of Strength and Selection of Cement-sand Ratio of Cemented Backfill: Lilou Iron Mine is the largest domestic underground backfill mining and uses advanced whole tailings cemented filling process system. For the backfill, both the change law of strength development and the cement-sand ratio are important considerations for design. A differentiation analysis was performed of the strength of laboratory test blocks at the age of 28d and in situ cemented backfill samples. When the filling slurry concentration was 72% and cement-sand ratio was 1:4, the in situ coring strength was 2.98 MPa higher than that of laboratory-cured specimens; when the slurry concentration was 68% and cement-sand ratios were 1:4, 1:6 and 1:8, the in situ coring strength was 1.68MPa, 2.33 MPa and 1.44 MPa higher than that of laboratory-cured specimens. With an increase of filling height, the change laws has been explored of downward parabola in conditions that the strength difference is consistent with the bulk density difference of the cemented backfill. The stress of cemented backfill with different ratios were calculated and analyzed on the basis of ANSYS numerical simulation and similar filling mines. According to the position of stress concentration and change law of strength difference, this paper proposes an design scheme for high-stage cemented backfill with ratio parameters at different heights.

The last paper of this issue is nineteenth by T.C. Ekneligoda, L.-T. Yang, D. Wanatowski, A.M. Marshall1, and L.R. Stace on Numerical modelling of Ground Subsidence at an Underground Coal Gasification Site. A detailed numerical modelling study was carried out by the authors to represent geotechnical aspects of the Wieczorek underground coal gasification (UCG) site in Poland. A coupled thermos-mechanical numerical model was created to represent a single coal burning panel. The coal burning process was simulated by modifying the energy balance equation with an additional term related to the calorific value of coal as a source. Temperature dependent material properties were assigned to the coupled thermal-mechanical model according to published data. In the model, the burning zone spread about 7.5m laterally after 20 days of burning. Results from the coupled model were used to gauge a worst-case scenario in terms of the potential size of a formed cavity. This data was used within a less computationally expensive mechanical-only numerical model in order to evaluate the ground subsidence caused by the worst-case scenario for single and multiple UCG burning panels. The single panel burning resulted in 23mm of ground subsidence at the top of the model after long term coal burning. The ground subsidence measured at the top of the model, at the centre point of the gasification arrangement, was approximately 72mm when five panels were burnt with an edge to edge panel distance of 5m; this was increased to 85mm for seven panels.

ACKNOWLEDGEMENT

Nineteen papers are contained in this issue. Twelve of them are assembled by the Guest Editors and another seven contributed papers directly to the in-house editors. No doubt the material contained herein would be most valuable to our profession. The editors have adequately described the contributions in the preface. They are to be congratulated for these contributions.

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

GEOTECHNICAL ENGINEERING

December 2017: Papers by Guest Editor Akira Murakami & Contributed Papers

Edited by:
Akira Murakami, San Shyan Lin & Mounir Bouassida

Akira Murakami

Prof. Akira Murakami received his BS (1978) at the Agricultural Engineering Department; MS (1980) at the Civil Engineering Department and Dr. Agr. (1991) from Kyoto University (KU), respectively. In 1982, he became an assistant professor at the Agricultural Engineering Department of KU, and was promoted to an associate professor of KU in 1994. He moved to the Graduate School of Environmental Science of Okayama University with a promotion to full professor in 1999. After joining Okayama University for just 10 years, he moved back to a full professor of KU in 2009. He has served as the Vice President of the Japanese Geotechnical Society (JGS), the Board Member of the Japanese Society of Irrigation, Drainage and Rural Engineering (JSIDRE), and the International Association for Computer Methods and Advances in Geomechanics (IACMAG), and also serves as a core member of TC103 of ISSMGE and a member of the Multidisciplinary International Society on Inverse Problems in Science and Engineering. He had acted as the Secretary of TC34 of ISSMGE for two terms and delivered a general report of 'Numerical Methods' at 16ICSMGE held in Osaka. He is the recipient of the Japanese Society of Civil Engineering (JSCE) Paper Award (1996), the JSIDRE Sawada Prize (2007), the JGS Best Accomplishment Award (2008), the JSIDRE Best Paper Award (2010), the JGS Paper Award (2011, 2013) and is a Fellow of JSCE. His research interests include the data assimilation, inverse problem, finite element methods, mesh free methods, and DEM in geomechanics.

San-Shyan Lin

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

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

Mounir Bouassida

Mounir Bouassida is a professor of civil engineering at the National Engineering School of Tunis (ENIT) of the University of Tunis El Manar where he earned his B.S., M.S., Ph.D., and doctorate of sciences diplomas, all in civil engineering. He is the director of the Research Laboratory in Geotechnical Engineering and has supervised 16 Ph.D. and 29 Master of science graduates. His research focuses on soil improvement techniques and behavior of soft clays. Dr. Bouassida is the (co)author of 87 papers in refereed international journals; 130 papers, including 20 keynote lectures; and three books. He is a member of the editorial committees of journals Ground Improvement (ICE), Geotechnical Geological Engineering, Infrastructure Innovative Solutions, and International Journal of Geomechanics (ASCE). He is also an active reviewer in several international journals. As a 2006 Fulbright scholar, Bouassida elaborated a novel methodology for the design of foundations on reinforced soil by columns. He was awarded the 2006 S. Prakash Prize for Excellence in the practice of geotechnical engineering. In 2008, Bouassida launched a Tunisian consulting office in geotechnical engineering, SIMPRO. He is a co-developer of the software Columns 1.01 used for designing column-reinforced foundations. Prof. Bouassida held the office of the vice president of ISSMGE for Africa (2005–2009). He benefited from several grants as a visiting professor in the USA, France, Belgium, Australia, Vietnam, Hong Kong, and Norway.

Geotechnical Engineering Journal of the SEAGS & AGSSEA Vol. **48 No. 4 December 2017** ISSN 0046-5828

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December 2017: Papers by Guest Editor Akira Murakami & Contributed Papers

Edited by:
Akira Murakami, San Shyan Lin & Mounir Bouassida

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Journal of the
SEAGS Southeast Asian Geotechnical Society
AGSSEA ASSOCIATION OF GEOTECHNICAL SOCIETIES IN SOUTHEAST ASIA
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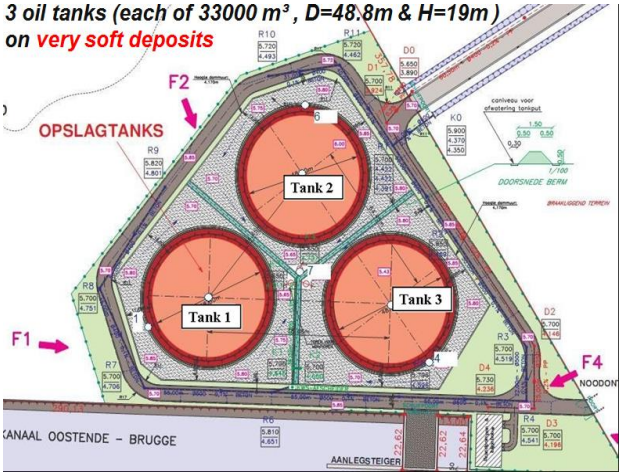
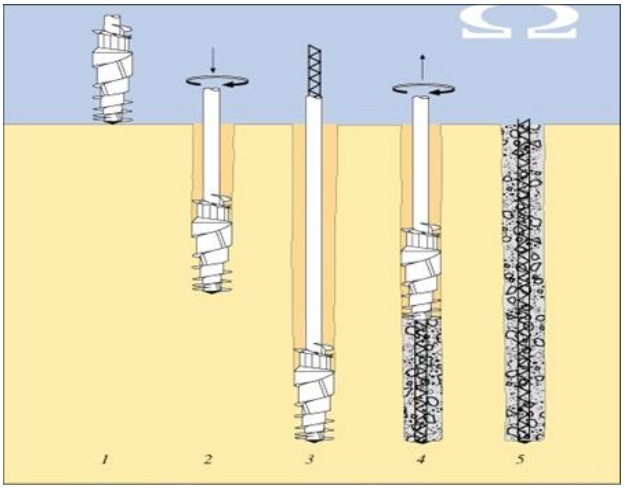
EDITORS: MADHAVI LATHA & MURALI KRISHNA

Prof Madhira Madhav Honoured with Special Issue March 2018 of SEAGS-AGSSEA Journal





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March 2018 Issue to Honour Prof Madhira Madhav

For his Contributions in Geotechnics through Indian Geotechnical Society, ISSMGE and Universities in IIT Kanpur, IIT Bangalore, Saga etc

Prof. M.R.Madhav, Visiting Professor, IIT, Hyderabad, Professor Emeritus, J.N.T.U, Hyderabad, Resource Person, Rajiv Gandhi University of Knowledge Technology, Chairman, Research Council, CSIR-CRRI, and Advisor/Consultant to Energy Infratech, Halcrow, KSK Infra, etc., retired as Professor of Civil Engineering, IIT, Kanpur. He graduated in Civil Engineering from Andhra University in 1960, obtained the Master of Engineering and the Doctorate of Philosophy degrees from the Indian Institute of Science, Bangalore in the years 1961 and 1967 respectively. Prof. Madhav worked at several universities - Sydney, Australia; Concordia, Canada, Saga, Saga, Japan; Ghent, Belgium, Queen's, Belfast, etc.. He was an Associate at the International Center for Theoretical Physics, Trieste, Italy, Vice President for Asia, International Society of Soil Mechanics & Geotechnical Engineering, advisor to Navi Mumbai SEZ, CRRI, New Delhi.

Prof. Madhav's research interests span the whole gamut of Geotechnical Engineering. He guided more than 45 doctoral and several master's theses and final year projects. He co-edited books entitled 'Lowlands - Development and Management' and on 'Foundations and Soft Ground Engineering Challenges in Mekong Delta, and authored more than 500 publications in refereed international and national journals and conferences.

Prof Madhav is well known internationally as a researcher, teacher and consultant. He established schools of research at IIT, Kanpur, and JNTU, Hyderabad in Geotechnical Engineering, was associated closely in developing the schools of research at the Institute of Lowland Technology, Saga and IIT, Hyderabad. His work on Modelling and Numerical Analyses of Geotechnical and Ground Engineering Problems is monumental. He has contributed to the Practice of Geotechnical Engineering as a Consultant and to the Indian Geotechnical Society as a Member of the Executive Committee, as a Reviewer for and Editor of the Indian Geotechnical Journal and as President.

Prof. Madhav delivered Keynote/Plenary Lectures, Chaired Technical Sessions in several International and National Conferences, was a Panelist in the XIII, XV and XVI International Conferences on Soil Mechanics and Geotechnical Engineering at New Delhi (1994), Istanbul (2001) and Osaka (2005). He delivered the prestigious Annual Lecture of the IGS, Keynote Lecture at the 12th Asian Regional Conference at Singapore, the Inaugural Miura Lecture at Busan, etc. He is Life Fellow of the Indian National Academy of Engineering, the Indian Geotechnical Society, The Institution of Engineers (India), etc. He is recipient of the Keucklemann Award of the IGS, the Prof. Mehra Research Award of the University of Roorkee, Pundit Jawaharlal Nehru Birth Centenary Research Award of CBIP, the Doctor of Science degree of the Indian Institute of Science, Distinction in Engineering Technology from the Central Board of Irrigation and Power, IGS – Prof. Dinesh Mohan Prize, etc. He was the President of IGS, and the Vice President for Asia of ISSMGE, the Vice President (1998-2010) and currently (2010 onwards) the President of the International Association of Lowland Technology. He has been awarded the Honorary Fellowship and Diamond Jubilee Honour by the Indian Geotechnical Society. He received the prestigious Bharat Ratna M Visweswaraya Award by Government of AP & Institution of Engineers

(I) AP State Centre, Gopal Ranjan Research award of IIT, Roorkee for Innovative and Outstanding Research, Outstanding Researcher Award from IANAMG, IGS-MS Jain Prize for Innovations in Piling, Vishwakarma Award for Academic Excellence from Construction Industry Development Council, IGS – H C Verma Diamond Jubilee Award for Innovative Instrument Design, the Distinguished Alumnus Award from the Indian Institute of Science, Bangalore in August 2014 (the second graduate from Civil Engineering) and the Prof. Dinesh Mohan Award for Excellence in Geotechnical Practice, etc. and delivered the most prestigious IGS-Ferroco Terzaghi Oration. Most recently, Prof. Madhav delivered the first Victor de Mello Goa lecture. Prof. Madhav pursues Origami as his hobby.

GEOTECHNICAL ENGINEERING

March 2018: Guest Editors

Edited by: Madhavi Latha & Murali Krishna

Madhavi Latha

Madhavi Latha is a Professor at IISc, Bangalore. She obtained her Ph.D. degree from IIT Madras. Prior to joining IISc in 2003, she was an Assistant Professor at IIT Guwahati for a year. Her research areas include geosynthetics, earthquake geotechnical engineering and rock engineering. She has so far supervised 10 Ph.D. students and published more than 150 technical papers. She is one of the geotechnical consultants for the world's highest railway bridge being constructed in Jammu, India. She is a member of ISSMGE Technical Committee on soil structure interaction and retaining walls and IGS Technical Committee on soil reinforcement. She is currently the Editor-in-chief of the Indian Geotechnical Journal.

Murali Krishna

Dr. A. Murali Krishna is a faculty member in Department of Civil Engineering at Indian Institute of Technology (IIT) Guwahati, since 2008. He obtained Doctoral degree from Indian Institute of Science Bangalore for his Ph. D work on "Shaking table tests on Geosynthetic reinforced soil retaining walls". He received his M.Tech degree from IIT Kanpur and B.Tech degree from Sri Venkateswara University, Tirupati. His research interests include: Earthquake Geotechnics, Geosynthetics and Ground Improvement, Site characterization and Numerical and Physical modelling of geotechnical structures. Dr. Murali Krishna supervised 4 Doctoral students and 20 Masters Students. He co-authored nearly 150 publications of technical papers in International/National Journals and Conference/Seminar Proceedings including book chapters. He is a recipient of BRNS Young Scientist Research award, BOYSCAST fellowship and HERTAGE fellowship. Dr. Murali Krishna is currently serving as an 'Executive Member' of the IGS and Member of TC 203 of ISSMGE, since 2011. He is the executive member of ISRM (India) and ISET. Dr. Murali Krishna organised national and international workshops and short courses. He is a reviewer for several national and international journals.

Preface

This Issue contains sixteen papers, the first ten was acquired by Profs Madhavi Latha and Murali Krishna to honour Prof Madhira Madhav and the other six are directly contributed papers to our Journal Office.

The first paper is by Harry G. Poulos on Rational Assessment of Modulus of Subgrade Reaction: The concept of modulus of subgrade reaction has been employed within the engineering world for almost 150 years. It has been especially embraced by structural engineers who have found it convenient to represent the behaviour of the ground supporting their structures by elastic springs. Despite the best efforts of the geotechnical profession to dissuade our structural colleagues from using this flawed concept in foundation design, requests to provide a modulus of subgrade reaction continue almost unabated. Given this situation, a suitable response is to provide such values via a rational process of evaluation, rather than by empirical correlations which have little theoretical basis and which may not be applicable to the foundation being considered.

This paper sets out an approach to the estimation of values of modulus of subgrade reaction for various types of foundation. The key points made are that the modulus of subgrade reaction (k) is not a fundamental soil property, but varies with the foundation type, foundation dimension, and type of loading. k can be related to the Young's modulus of the supporting soil and to the foundation dimensions, but for pile groups, account must be taken of the reduction in k because of group effects arising from pile-soil-pile interaction. It is also emphasized that careful distinction must be made between the modulus of subgrade reaction, k, and the spring stiffness K.

The second paper is by S**.** Basack, B. Indraratna and C. Rujikiatkamjorn on Effectiveness of Stone Column Reinforcement for Stabilizing Soft Ground with Reference to Transport Infrastructure: The use of stone columns for soft soil stabilization has numerous advantages compared to other methods. There are many factors controlling performance of stone columns including column geometry and particle morphology. The reinforced soft ground supporting transport infrastructure like the railways and highways is subjected to cyclic loading, usually initiating a partially drained condition. The study reveals that the stone columns are more effective in mitigating the built up of cyclic excess pore water pressure compared to conventional vertical drains. This paper presents a brief overview on the rigorous theoretical and experimental studies carried out by the Authors to investigate the effectiveness of stone column reinforcement for stabilizing soft ground with particular reference to transport infrastructure.

The third paper on Pile design and group behavior; a case study of large tank foundations in soft soil conditions is by W.F. Van Impe, P.O. Van Impe and A. Manzotti: The paper presents the case study on the construction of three 48m diameter oil tanks in Ostend (Belgium), each founded on a group of 422 displacement cast in-situ screw piles. The three tanks are close enough to each other to induce interaction. Monitoring of the tanks' movements has been performed during the hydro-testing of the steel tanks and during the subsequent working stage of the tanks. The bearing layer of the pile group is a 5m thick stiff sand layer at a depth of about 20m, overlain by a very heterogeneous soft clayey/silty fill containing sand pockets, and underlain by very thick slightly over-consolidated clay. Some short and long term settlement prediction of the tanks have been done, assuming soil parameters derived from the CPT data on site, and compared to the measured settlements. The initially derived soil parameters are then re-evaluated in order to predict the long term settlement for the full life span of the construction.

The fourth paper is by V Sivakumar on Granular Columns for Geotechnical Applications: Soft clay deposits are globally widespread and often coincide with strategic transport links and growing urban developments. These soft deposits are often waterlogged and are composed of clay with varying degrees of silt, sand and organic matter. These soils have low undrained shear strength and high compressibility, contributing to construction

problems in relation to stability and settlement. Granular columns, also referred to as flexible piles, are one of the techniques widely considered in the industry for improving soft deposits for low-moderate structural loading. The purpose of this article is to highlight some of the key investigations carried out in the topic of granular columns at Queen's University Belfast, the UK.

The investigations focused on several aspects: (a) the interaction between columns and surrounding clay (b) containment of columns in geo-grid for enhanced strength performance (c) settlement performance under single or multiple column configuration (d) stress distribution under the footing and along the column (e) assessment of consolidation and creep settlement under constant loading and (f) granular columns for anchoring purposes and therefore stabilization of slopes. Overall observations are: settlement improvement factors were moderate under isolated loading, but granular columns are very effective in providing pull-out capacity in the form of anchors.

The paper entitled Ground Engineering Using Prefabricated Vertical Drains: A Review is the fifth paper by V.A. Sakleshpur, M. Prezzi, and R. Salgado: Improvement of soft ground by preloading with prefabricated vertical drains (PVDs) is a common practice in the field of ground engineering. PVDs accelerate the consolidation process of soft soils by providing a shorter drainage path for the pore water and thereby increase the strength and stiffness of soft soils over time. This paper presents a review of recent analytical, laboratory, numerical and field studies performed using preloading with PVDs for improvement of soft ground. The focus of the paper is on conventional PVDs without the use of vacuum, thermal and electro-osmosis techniques. Summary tables, which provide quick and easy access to the latest information from various research efforts, have been prepared and discussed. The review is complemented by two case histories that highlight the performance of PVDs in the field.

The sixth paper is on Soil Reinforcement under Oblique Pull- An updated Discretization by S Patra & J.T. Shahu: Reinforced soil structures are gaining popularity for a variety of reasons mainly because it is safe, economical, aesthetic and rapid in constructions. However, the actual behaviour of these structures at failure is still not properly understood. The present study attempts to evaluate the internal stability of these structures against pullout failure. Kinematics of failure suggests that the failure surface intersects the reinforcement obliquely causing an oblique pullout of the reinforcement. In this paper, an updated discretization technique is used to determine the pullout capacity of an inextensible reinforcement resting on a linear elastic Pasternak subgrade and subjected to an oblique end force. A parametric study is conducted and a new factor, length correction factor is introduced in the present analysis. The correction factors have a significant influence on the pullout response especially for high values of obliquity and end displacement. Present analysis thus gives a more realistic value of pull out capacity which is required for the internal stability analysis and design of reinforced soil structures. A case study is also presented to validate the proposed analysis. The maximum reinforcement tension is predicted for top few reinforcements using the proposed method and the AASHTO Simplified Method. The present analysis gives a better prediction of the mobilized reinforcement tension compared to the AASHTO method.

The paper by Madhavi Latha G and Manju G. S. is the seventh paper on Effect of Facing Slope on the seismic response of Geocell Walls: This paper presents the effect of slope angle of facing on the seismic response of retaining walls with geocell facing. Keeping the dimensions and configuration of geocell layer same, shaking table model tests were carried out with vertical and battered walls retaining sand backfill. In case of battered walls, geocell layers were laid with an offset, resulting in an overall slope of the wall. Vertical walls were constructed with geocell layers stacked vertically above each other. Gravel was used as infill material in geocells. Models were subjected to different levels of ground motion conditions by controlling the acceleration and frequency of shaking. Acceleration amplitudes of 0.2g and 0.3g with frequencies ranging between 1 Hz and 7 Hz were used in the model tests. Response of models was monitored with cyclic shaking at intended acceleration and frequency by measuring the face deformations and acceleration amplifications along the height

of the retaining wall, Results from model tests showed that battered walls perform better than the vertical walls since the measured deformations and acceleration amplifications were comparatively low in battered walls. The improved performance of battered walls is due to the increased stiffness and increase in dynamic impedance caused due to shifting of moment of inertia of pressure distribution at the back of the wall in case of walls battered towards the backfill.

The eighth paper is on Evaluation of Resilient Modulus of Geosynthetic Reinforced Layers Using Repeated Load Triaxial Tests by Sudheer S Prabhu, Lekshmi Suku and G L Sivakumar Babu: The stiffness and strength of the pavement layers are the major parameters that influence the design of highway pavements which in turn decides the thickness of various pavement layers. Studies have shown that the thickness of the base layer plays a crucial role in limiting the rutting of the in situ subgrade soil. Due to the lack of availability of aggregates, there is a dire need to minimize the thickness of the base. Geosynthetics in the form of geogrid and geocell have long been used for reinforcing unbound base/subbase layers in paved and unpaved roads and have been found to be effective in reducing the base thickness. A few laboratory studies have been conducted to evaluate the different aspects of geosynthetic reinforced base layers, and further studies are required to examine the behavior of these reinforced sections under elastic and plastic shake down range. The purpose of the current study is to evaluate and compare the resilient modulus of geogrid reinforced, geocell reinforced and the unreinforced granular base under repeated loading using the Repeated Load Triaxial tests. The response of aggregate under repeated loading expressed in terms of resilient modulus is a key parameter in the new Mechanistic Empirical Pavement Design Guide (MEPDG). The permanent strains of aggregates are also compared in the study to get an overall idea about the reinforcement effect in the granular base.

The paper by Ritwik Nandi and Deepankar Choudhury is the ninth paper on Seismic Analysis of Reinforced Soil Wall Considering Oblique Pullout of Reinforcements: A Review: Several methods are available for stability analysis of reinforced soil structures. However, most of these methods mainly concentrated on the horizontal pullout of the reinforcement in spite of the evidences available that show the failure surface of reinforced soil structure will always intersect reinforcement layers diagonally due to the failure kinematics. It will cause oblique/transverse deformation to reinforcements across the failure surface. In the present paper, state-of-the-art review of earthquake stability analysis of reinforced soil-wall by employing the oblique/transverse pull of reinforcements is discussed. Formulations that are developed in various studies to determine the mobilization of diagonal pullout resistance of reinforcements, the amount of drag force triggered in the reinforcement sheets due to instability in the structure and the factor of safety against pullout are presented. A comparative study is also carried out between existing models and methods that are used in determining the seismic stability of reinforced soil structure subjected to diagonal pullout of soil reinforcements. The comparative study shows the effect of various models and methods on the factor of safety against reinforced soil-wall stability and the influence of different parameters i.e., horizontal seismic acceleration, internal friction angle of soil, interface friction angle of soil and reinforcement, relative subgrade stiffness factor etc. Depending on the model used in analyses, the computed factor of safety may vary significantly.

The tenth paper is by Nevin Koshy, S. U. Sushalekshmi, Susmita Sharma, Jeevan Joseph, Vikas, D. N. Singh, Bhagwanjee Jha and M. Singh on Characterization of the Soil Samples from the Lonar Crater, India: The Lonar crater and its enclosed lake have been a universally recognized young and well preserved meteoritic formation in the state of Maharashtra, India. Previous studies on the uniqueness (salty and alkaline nature) of sediments (the crater soil) and the lake water, hint at its creation by meteor impact and post-impact induced hydrothermal interaction between the meteor and the then earth surface in the region. Also, the earlier reports confirm the sediments as basaltic rock, in nature. However, not many efforts have been made by the present generation of researchers for detailed chemical and mineralogical characterization of the sediments, which may reveal an analogue relationship between the crater sediments and a meteor (the lunar or the Martian soil) from the space. In this context, the present study attempts to understand the characteristics of the soil samples extracted from the crater region, with respect to their physical, chemical, mineralogical, electrical and magnetic properties. The

findings also shed light into the response of the crater samples when subjected to different energy fields (viz., mechanical, chemical, electrical and X-rays). Based on a critical synthesis of the results, the characteristics (viz., alkalinity, saltiness, geological-structural properties, water-sediment interaction) of the sediments have been showcased and evaluated for their partial conformity with extraterrestrial objects (i.e., the meteors).

The eleventh paper by J. Jayapal & K. Rajakopal is on Encased Columnar Inclusions in Soft Grounds - A Review: Even before the evolution of soil mechanics, the research on mitigating the problems induced by soft soils has started. The granular column is one of the promising ground improvement technique widely accepted as a solution to soft soil problems all over the world. Recently the performance of it is improved by encasing with geosynthetic products like geogrid and geotextiles. This paper gives an insight into the technical aspects of encased granular columns by reviewing the advancements that have happened in the published literature. The focus of this paper is more on the problems associated with soft clay deposits, although granular columns can also be employed to mitigate liquefaction in saturated loose sand deposits. Discussions on the key technical aspects associated with encased granular columns and its applicability in the field are provided.

The twelfth paper by P. A. Faby Mole, S. Sireeshand M. R. Madhav on Influence of Shear Stiffness of Geocell Mattress on the Performance of Strip Footings- A Numerical Study**:** A modified Pasternak model was proposed to predict the behaviour of a strip footing resting on a geocell reinforced granular layer overlying weak soil, especially considering the variation of shear stiffness of the geocell mattress. Both linear and nonlinear responses of the geocell reinforced beds were considered in the analysis. Results from the present model were validated with independent experimental load-deformation responses. The model parameters viz. inverse of normalized shear stiffness of the geocell and inverse of normalized ultimate bearing capacity of foundation soil were varied for the parametric study. It was found that the shear stiffness of the reinforced granular bed i.e. the product of shear modulus and the height of the geocell reinforced granular bed plays an important role in improving the performance of the foundation system. Design charts are presented in the form of improvement factors for the practical range of shear layer width, shear stiffness of the geocell reinforcement and ultimate bearing capacity of the soft soil**.**

The thirteenth paper is on Interference of Two Closely-Spaced Footings on Finite Sand Layer by Macharam Rohith, Sasanka Mouli, and Umashankar Balunaini: Bearing capacity of footing is influenced by the presence of adjacent footing. In this study, two closely-spaced strips, square, and circular footings are modelled in finite elements using commercially available software - PLAXIS 2D and 3D. Analysis is done considering both smooth and rough footing bases. The effect of spacing between the footings is examined for footings resting on both semi-infinite and finite sand layers. In addition, angle of shearing resistance of foundation soil is varied from 30° to 40° to investigate its effect on the bearing capacity. Bearing capacity of footings with rough base are found to attain a peak value at a particular spacing indicating the “blocking effect”. For square and circular footings, interference due to spacing is found to be insignificant compared to strip footing. Interference factors for rough footings are found to be higher than that for smooth footings.

The fourteenth paper on Stone Columns/Granular Piles for Improving Liquefiable Sites: Case studies are by A. Murali Krishna, A. Madan Kumar, Utpal Kr. Baruah: Liquefaction is considered as a major hazard among different seismic risks. Ground improvement methods are commonly adopted to improve the liquefiable sites. The paper presents various aspects of liquefaction mitigation strategies to be implemented for liquefaction susceptible sites with focus on granular inclusions. A short discussion on liquefaction susceptible soils and its evaluation followed by outlines of the ground engineering applications is presented herein. Mechanisms that function at sites treated with stone columns/granular piles for liquefaction mitigation are discussed. Design aspects of granular piles for liquefaction mitigation are outlined. Few case studies, wherein stone columns have been adopted for improving the liquefiable sites, are presented. The paper concludes and highlights the effectiveness of granular inclusions in improving the liquefiable sites through various mechanisms.

The paper on Biogeotechnological Methods for Mitigation of Liquefaction is the fifteenth by S. Wu, B. Li, J. He and J. Chu: Liquefaction of granular soils during earthquake has long been identified as one of the major geohazards. Conventional soil improvement methods for mitigating liquefaction such as dynamic compaction or deep mixing are costly for large-scale applications. Recently some biological processes have shown significant influence on both the physical and chemical performance of geotechnical systems. Two types of biogeotechnological methods, biocementation and biogas desaturation, have been experimentally examined in this study. For the former, a microbial induced carbonate precipitation (MICP) process has turned one cubic meter of loose sand into sandstone-like material. The shear strength of the sand is greatly improved whereas the permeability is reduced at the same time. For the later, tiny inert gas bubbles are generated microbiologically within liquefaction prone ground to increase the resistance of sand to liquefaction. A series of shaking table model tests on biogas treated sand have demonstrated that this biogas desaturation method is effective for reducing pore pressure generation and shaking induced settlement during cyclic loading. When the degree of saturation of the soil is controlled to be around 90%, the generation of pore pressure in sand and the potential for liquefaction could be largely contained.

The last paper in this issue is the sixteenth paper on A Critical and Comparative Study on 2D and 3D Analyses of Raft and Piled Raft Foundations by V. Balakumar, Min Huang, Erwin Oh and A. S. Balasubramaniam: The piled raft foundation has gained a very high level of acceptance as a foundation system whenever settlement alone governs the design. In the design of piled raft many of the traditional methods could not be applied due to the complex nature of interactions involved. Hence there is a need to use detailed three dimensional finite element analyses for the final design. But in the initial stages of design a simpler but effective analytical process need to be used to save the computational efforts. Since the primary requirement in the piled raft design is the design of optimum pile group to achieve the desired settlement reduction, through number of trials, the applicability of simpler two dimensional analyses are examined to save the computational efforts during the initial trials. It was found that simple two dimensional analyses provide results of acceptable accuracy for the design office requirements.

Madhavi Latha
Murali Krishna

ACKNOWLEDGEMENTS

Sixteen papers are contained in this issue. The first ten was acquired by Profs Madhavi Latha and Murali Krishna to honour Prof Madhira Madhav and the other six are directly contributed papers to our Journal Office. No doubt the material contained herein would be most valuable to our profession. The editors have adequately described the contributions in the preface. They are to be congratulated for these contributions.

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

GEOTECHNICAL ENGINEERING

March 2018: Issue to Honour Prof M. R. Madhav for his Contributions in Geotechnics Through Indian Geotechnical Society, ISSMGE and Universities in IIT Kanpur, IIT Bangalore, Saga etc.

Edited by:
Madhavi Latha & Murali Krishna

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Geotechnical Engineering Journal of the SEAGS & AGSSEA

Vol. 49 No. 2 June 2018

ISSN 0046-5828

GEOTECHNICAL ENGINEERING

Journal of the

SEAGS Southeast Asian Geotechnical Society

AGSSEA ASSOCIATION OF GEOTECHNICAL SOCIETIES IN SOUTHEAST ASIA

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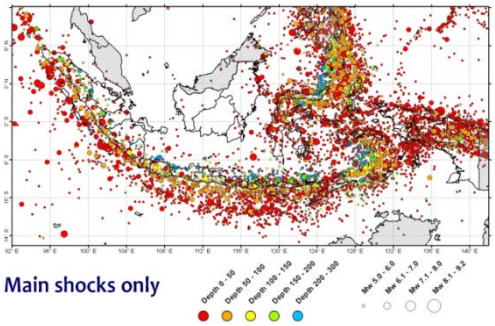

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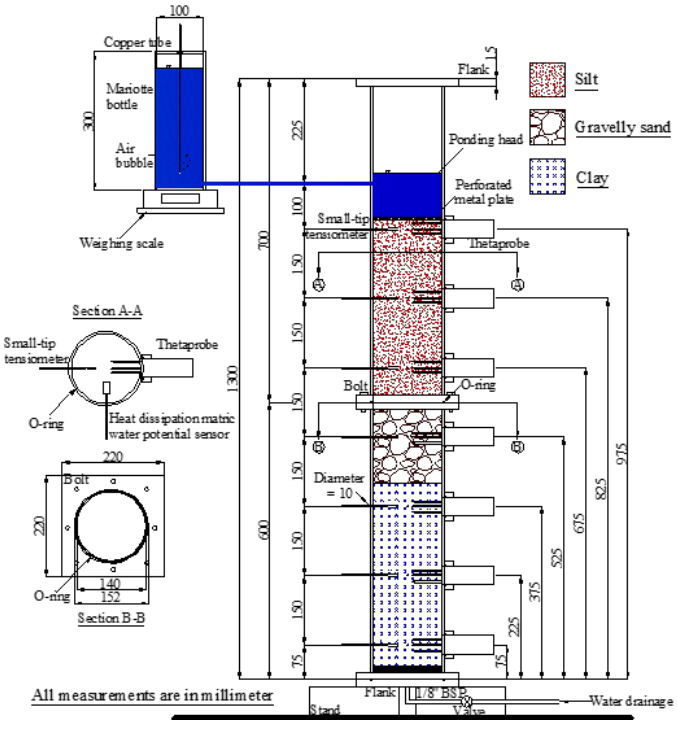

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GEOTECHNICAL ENGINEERING

June 2018: Part 1 papers of SEAGS 50th Anniversary

Edited by: NOPPADOL PHIENWEJ, SUTTISAK SORALUMP, APINITI JOTISANKASA, SUCHED LIKITLERSUANG AND TIRAWAT BOONYATEE

Dr. Noppadol Phienwej

Dr. Noppadol was an Associate Professor in Geotechnical and Earth Resources Engineering in AIT's School of Engineering and Technology (SET).He became SEAGS President in May 2016. Prior to taking over as President, Dr. Noppadol was serving as Honorary Secretary General of SEAGS. Other AIT faculty members who have served as Secretary General of the Society include Dr. John Nelson (1970-1973), Prof. A.S. Balasubramaniam 1972-2000), and Prof. D.T. Bergado (2000-2013). Prof. Balasubramaniam has also served as President from 1985 – 1987. AIT's association with SEAGS stems back from 1967, when the Society was founded at AIT Bangkok by Dr Za-Chieh Moh, a former AIT faculty member, to cover Thailand, Malaysia, Singapore, Hong Kong and Taiwan and other societies in Asia. With a membership of over 200, the Society members are active in soil mechanics and foundation engineering, engineering geology, rock mechanics and geosynthetic engineering.

Dr Suttisak Soralump

Dr Suttisak Soralump is currently an Associate Professor at Kasetsart University in Bangkok, Thailand. He is also the President of the Thai Geotechnical Society. An Alumnus of Chulalongkorn University in 1994, he is also a Distinguished AIT Alumnus who received his Doctoral Degree from Utah State University in 2001. Dr Suttisak has wide range of Geotechnical Engineering interest and these include: ground improvement techniques, risk assessment and analysis of dams, dam engineering, probabilistic analyses, as well as field and laboratory testings. Dr Suttisak is an active geotechnical consultant in Thailand and under his leadership; the Thai Geotechnical Society has arranged conferences, symposia and courses. The Annual Thai Geotechnical Conferences are worthy of praise.

Prof. Suched Likitlersuang

Prof Suched Likitlersuang is currently a full professor at the Department of Civil Engineering, Faculty of Engineering, Chulalongkorn University. He joined the Department of Civil Engineering at Chulalongkorn University as a lecturer (2004-2006), as an assistant professor (2006-2009) and as an associate professor (2009-2011). He was promoted to full professorship in 2011. He is also the founder of the Geotechnical Research Unit, which came into being in early 2016. His research interests include constitutive modeling for geomaterial, stress-strain characteristic of soils, numerical analysis in geomechanics, pavement engineering, geoenvironments, geotechnical earthquake engineering and soil bioengineering. He has supervised 24 Master and 10 Ph.D. students. He has published over 80 articles in international conference proceedings and international journals. Suched Likitlersuang was born in Bangkok. He graduated with a bachelor degree in civil engineering from Chulalongkorn University in 1998 and received a master degree in geotechnical engineering from Asian Institute of Technology in 2000. He obtained a doctorate in civil engineering from the University of Oxford in 2004.

His contributions through research to innovative design and construction practices in geotechnical engineering and problematic ground improvement have been widely recognized. He received many research grants from national and international agencies. Recently, his works have moved closer to industrial needs by collaborating with the private and non-governmental sector in the implementation of innovative research-based solution. He is a member of the Thai Geotechnical Society and the Engineering Institute of Thailand. He is also an Editorial Board member of Geotechnical Research and serves as Editor of the Southeast Asian Geotechnical Society Journal. He has also served as a reviewer in many reputable journals.

Dr. Apiniti Jotisankasa

Dr. Apiniti Jotisankasa is currently an Associate Professor at Department of Civil Engineering, Kasestsart University Bangkok. After obtaining his BEng degree in Civil Engineering from Kasetsart University in 1999, he pursued his MSc and PhD in Soil Mechanics at Imperial College London with the generous support of the Anandamahidol Scholarship from Thailand. His research topics were the Collapse behaviour of compacted silty clay.

Since 2005, he focused his research activities on application of unsaturated soil mechanics on practical geotechnical engineering problems, such as rainfall-induced landslide, excavation, embankment stability, bio-slope engineering, geohazard mitigation, as well as other issues such as energy piles, tree stability, and geophysics investigation for tree root architecture. He and his team has been developing a system for monitoring slope behaviour such as suction, pore water pressure, slope movement and earth pressure. Dr. Apiniti is the recipient of the best paper award (Geotechnical Engineering) in the National Convention in Civil Engineering twice in 2009 and 2012 from the Thai Geotechnical Society and Chai Mukthabhan foundation for his comprehensive works on the behaviour of slopes subject to rainfall.

In 2011, he was awarded the Young Technologist Award from the Foundation for the Promotion of Science and Technology under the Patronage of His Majesty the King of Thailand. Dr. Apiniti has been international Secretary General of the Thai Geotechnical Society since 2009 and currently a member of the TC106 (Unsaturated soils) of the International Society of Soil Mechanics and Geotechnical Engineering. Currently; he is a committee member of the Chaipattana Foundation working on the project on landslide hazard mitigation by the use of vegetation and engineering methods.

Dr. Apiniti was a conference secretary of the 5th Asia-Pacific conference on unsaturated soil in 2012 and the 50th anniversary symposium of SEAGS in 2017. Currently, he serves as an editorial board member of Soils and Foundations Journal of the Japanese Geotechnical Society and International Journal of Geosynthetics and Ground Engineering, Springer.

Dr Tirawat Boonyatee

Dr. Tirawat Boonyatee is currently an Associate Professor in Geotechnical Engineering at the Department of Civil Engineering, Faculty of Engineering, Chulalongkorn University. He obtained his B.Eng. (Civil Engineering) at Chulalongkorn University, Thailand, in 1995 and furthers his studies at Kyoto University, Japan where he obtained his M.Eng. (Civil Engineering) in 1998 and D.Eng. (Civil Engineering) in 2001respectively. Dr Tirawat Boonyatee is a committee member of Subcommittee on Geotechnical in Civil Engineering Committee of The Engineering Institute of Thailand Under H.M. The King's Patronage.

PREFACE

This volume contains 20 papers from invited authors from SEAGS-AGSSEA member countries, Japan, Korea, India and elsewhere.

1. The first paper by Charles W.W. Ng, Jason L. Coo & Anthony Gunawan deals with "State-of-the-Art Research in Geo-energy and Geo-environmental Engineering: Energy Pile and Earthen Capillary Landfill Cover System". Geo-energy and geo-environment are two branches of geotechnical engineering representing current and future grant challenges because of the pressing need to conserve energy and protect the environment. The Hong Kong University of Science and Technology has been actively seeking solutions to these two challenges. The first part (geo-energy) of this paper describes a series of novel cyclic heating and cooling centrifuge tests performed on replacement and displacement floating energy piles installed in both saturated sand and clay. The test results reveal that replacement floating energy piles exhibit ratcheting settlement under a constant working load but at a reducing rate when subjected to temperature cycles, irrespective of the type of soil in which they are embedded. On the contrary, displacement floating energy piles exhibit heave behaviour. No existing theoretical model can capture observed ratcheting pile settlement well. This suggests that care must be taken when designing replacement floating energy piles. In the second part (geo-environment) of the paper, a novel three-layer environmentally friendly earthen cover system for climate regions like Thailand, Indonesia, the Philippines, Malaysia and Singapore is investigated through theoretical examination, physical modelling (e.g., one-dimensional soil column and two dimensional large flume tests), and advanced numerical simulations. This novel cover system consists of a fine-grained soil underneath a conventional two-layer cover with capillary barrier effects. Two-dimensional water infiltration experiments and numerical simulations show that the newly introduced fine-grained soil layer can greatly minimize rainfall infiltration even after a 4-h rainfall event having a return period of 100 years in climate regions. One-dimensional gas emission tests and numerical simulations reveal that a minimum of 0.6 m thick fine grained soil layer compacted at 10% saturation (e.g. those in arid regions) can adequately satisfy the Australian guidelines. No geomembrane is needed. This new environmentally friendly and robust earthen landfill cover system is thus a promising alternative to other landfill covers for minimizing rainfall infiltration and landfill gas emission under all kinds of weather conditions.

2. Yin & Feng in the second paper deal with the "validation of a new simplified Hypothesis B method for calculating consolidation settlement of clayey soils exhibiting creep". This paper introduces a new simplified Hypothesis B method for calculating consolidation settlement of clayey soils exhibiting creep. The general equations of the new simplified Hypothesis B method are presented and explained first. After this, four different cases are used to examine the validation of this new method. The first case is a single layer of clay with test data. Two fully coupled finite element (FE) programs, the new method, and Hypothesis A method are used to calculate the consolidation settlements of the clay which are compared with test data. The second case is one layer of Hong Kong Marine Deposits (HKMD) with four different over-consolidation ratios. Again, the two FE programs, the new method, and Hypothesis A method are used to calculate the consolidation settlements of the HKMD with results compared and relative errors obtained. The third case is two layers of soils: one is HKMD and the other is Alluvium. One commercial FE program, the new method, and Hypothesis A method are used to calculate the consolidation settlements of this two-layer system. Two methods for determining the average degree of consolidation of the two layers are used in the new simplified method. All results in this case are compared with relative errors obtained. The fourth case is one layer of Hong Kong Marine Deposits (HKMD) with vertical drain. The commercial FE program, the new method, and Hypothesis A method are used to calculate the consolidation settlements of this HKMD with vertical drain. Two methods for determining the average degree of consolidation of the HKMD with vertical drain are used in the new simplified method. Results from the FE analysis and the new method are compared with relative errors obtained. From the above validation cases, it is found that the settlements from the new simplified Hypothesis B method are closer to test data or the values from the fully coupled finite element modelling with least relative errors. Hypothesis A normally underestimates the settlement a lot and with largest errors when compared with Hypothesis B. The main conclusion is that the new simplified Hypothesis B method is very suitable for calculating consolidation settlement of clayey soils exhibiting creep and is easy to use by simple spreadsheet calculation.

3. The third paper is by Chao-Kuang Hsueh et al on "Finite Element Analysis to Characterize the Lateral Behaviour of a Capped Pile Group". Finite element simulation for analysis of a capped pile group was conducted to investigate the interaction among piles, soil and pile cap, especially the effects resulted from concrete damaging. The simulation was to develop a calibrated model using the test data and to apply that model for conditions not present during the test. In addition to consider pile/soil and cap/pile interaction in the numerical simulation, interaction between steel

reinforcement and concrete was also modelled in the analysis. In the numerical analysis each steel reinforcement installed in the tested piles and the pile cap was modelled as an individual element at its installed position. The simulation results showed that the leading and the middle row piles in the group carried the highest and the lowest fraction of pile head loads when concrete around the pile cap/soil contact area remained its integrity. Increasing loading level, the pile head load carried by the middle row of piles increased due to constraint of the pile cap affected by the concrete damage at the pile cap/soil contact zone.

4. The fourth paper is by Tjie Leong Gouw on "Proposed Design Guideline of Dynamic Compaction for Practicing Engineers". During an earthquake, saturated fine sands tend to lose its bearing capacity due to the earthquake induced and accumulated excess pore water pressure. The phenomenon, known as liquefaction, is one of the earthquake hazards that need to be mitigated in an earthquake prone area such as the archipelagos of Indonesia. The occurrence of an earthquake cannot be prevented and, with the present knowledge, is difficult - if not impossible - to predict. However, liquefaction potential can be mitigated by carrying out proper ground improvement methods. The most common ground improvement schemes that have been widely implemented in mitigating liquefaction potential of saturated fine sands in Indonesia are dynamic compaction and vibro-compaction. However, many practicing engineers are still not familiar with the methods. This paper presents the design, execution, and evaluation methods of dynamic compaction. Two case histories on real projects are also presented as examples.

5. Yasuhara et al are authors of the fifth paper on "Settlement of river dykes and their adjacent residences on soft clay deposits after the Tohoku-Pacific Ocean Earthquake of 2011." Among the cases of extensive infrastructural collapse that resulted from the cataclysmic earthquake that struck off the eastern coast of Japan on March 11, 2011, long-term settlement and deformation of clay deposits during earthquakes have sometimes been overlooked. This paper presents a case history of clay deposit settlement and deformation beneath river dykes and their adjacent residences after the Great East Japan Earthquake in 2011. As a countermeasure against damage of this kind, parts of existing river dykes were removed and then sheet piles were installed immediately after the earthquake at the toes of river dykes. Thereafter, the river dykes were returned to the original height by surcharging the fills for dykes. In addition to measurement of river dyke and residence behavior after those countermeasures, numerical analysis was conducted using ALID software for dynamic analysis of behavior during earthquakes and DACSAR software for static analysis of post-earthquake behavior to predict settlement and deformation of deposits consisting of the thick clay layer underlying the sand layer and to verify effectiveness of the countermeasures.

6. Sixth paper is by Dong Huyn Kim et al on Application of photogrammetry and image processing for rock slope investigation: High-resolution 3D photogrammetric models facilitate the generation of rock surface attributes which can be used to highlight the products of weathering on rock slopes. Recent studies of image analysis have also demonstrated that if the features of interest are clearly visible in digital photographs, various surface features which are associated with its weathering characteristics can be investigated using image analysis techniques. However, combining their potential of both 3D and 2D images for providing more reliable data, these approaches are computationally complicated and difficult to implement. This article presents an image analysis workflow via a MATLAB image filtering code for the estimation of a recession area focusing on the variation of rock surface roughness. By comparing annual photogrammetric 3D images, the roughness variations were processed with relative brightness integers (I) obtained from their greyscale images. The results show that the loss of roughness on the exposed surface appeared to be strongly related to the changes of brightness integers (I) derived from filtered greyscale images. The combined image analysis with 3D photogrammetric models could compensate the limitations of the uses of both digital photographs and 3D surface models for quantifying weathering patterns.

7. The seventh paper is by Boon & Ooi on advances in tunnelling Geotechnics – stacked twin tunnels: The construction of underground metro projects involves both tunnelling and deep excavations for station construction. The construction programme of the contractor needs to take into account the time required for excavating the launching shaft or station to launch the tunnel boring machines (TBMs), and also the interfacing of the tunnelling activities with the intermediate stations located in between the launching and retrieval shafts or stations. Risks in construction programme may arise in a project for instance due to land issues such as merger and acquisition or relocation of the original land occupants. The risks in construction programme can nonetheless be addressed through design provided there is strong understanding of its mechanics. This also allows more optimal construction programmes to be developed at the outset of a project. An example is demonstrated for the unusual case of stacked twin tunnels in residual soils where the upper tunnel is constructed first and undermined subsequently by the lower tunnel. The mathematics and the mechanics governing their interactions are detailed.

8. Shaw-Shong Liew is the author of the eighth paper on Common Blind Spots in Ground Investigation, Design, Construction, Performance Monitoring and Feedbacks in Geotechnical Engineering: In geotechnical engineering dealing with risks and uncertainties, the processes involved start from the investigation with the fundamental intention to attain better understanding of the subsurface conditions and acquisition of the engineering parameters for the subsequent engineering analyses, designs, detailing, tender documentation and calling, followed by design validation tests at field and construction problem solving. With the forensic investigation experiences by the author in the past, some interesting findings and surprises are compiled in this paper to illustrate these common blind spots at the aforementioned engineering processes. The importance of desk study and sound geological knowledge in planning of investigation programme have not received sufficient emphasis in the higher education system, thus resulting in significant wastage by the trained graduate in using the investigating tools and generating excessive amount of redundant information. Some of the mistakes are fundamental errors in perceiving the engineering behaviours when using the software with intuitive and illusive perception rather than based on sound engineering understanding. There is also strain compatibility issue in mobilising material strength of composite materials with drastic stiffness contrast when approaching failure state of a soil structure interaction problems. Design validation tests are crucial to ensure design methods adopted able to reasonably behave as intended. However, the tests usually do not reveal the overall behaviours of the design in actual scale and time factors, but rather a behaviours of a special case or prototype. Geotechnical instrumentation on a larger scale with time might be a more representative of practical performance with totality. This will be more useful for review and back-analysed of a big picture performance of the geotechnical structures.

9. The ninth paper is by Dr Dominic Ong on “detrimental effects of lateral soil movements on pile behaviour”. Deep excavation, tunnelling and river tidal fluctuations are some activities that can induce lateral soil movements, which can detrimentally impact nearby existing infrastructure. One major design concern is that the behaviour and mechanisms of complex soil-structure interaction that occur in these situations are often still not well understood. Limited design methods are currently available to evaluate these problems in practice. Therefore, the latest development and understanding of soil-structure interaction involving pile foundations subject to lateral soil movements are presented with reference to successfully implemented projects and research outcomes based on finite element modelling, centrifuge experiments as well as field observations and interpretations. The novel concept of passive pile behaviour and limiting soil pressure due to stress relief will be evaluated and explained in detail.

10. Tenth paper is by Siau Chen Chian on Optimising Cement Dosage in Ground Improvement and Early Quality Control Schemes: Judicious dosage of cement in soft clayey soils is key in reducing waste, time and cost in this growingly environmental conscious modern society. Despite being a well-established technique in ground improvement, studies on the prediction of strength development of cement stabilised soils are often limited to a couple of clay types or site specific. This paper presents an extensive suite of unconfined compressive strength tests of cement-mixed clayey soils over a wide range of mix ratios, curing ages and sand impurities. A strength predictive model encompassing the above variables was developed and validated with several types of clay and cement from different sources. This enables the optimisation of cement dosage to achieve a desirable unconfined compressive strength to satisfy the ground improvement criteria with ease. Quality control schemes using early age strength and portable bender element were also discussed in this paper.

11. Effects of Preloading of Struts on Retaining Structures in Deep Excavations” is the eleventh paper by Richard N. Hwang and Lup-Wong Wong. The performance of an excavation of 19.4 m in depth in soft ground has been reviewed by interpreting the readings of inclinometers in wall of 35 m in length and strain gauges in six levels of struts. Assuming the wall deflections at the first strut level would not move after preloading, the corrected inclinometer readings show that the deflections at the wall toes and at the tips of inclinometers were as much as 43 % and 25 % of the maximum wall deflections respectively. The large toe and tip movements are verified by numerical analyses, which have been conducted to study the effects of preloading of struts as well. The strain gauge readings show that the preloads applied to the struts do not sustain and drop significantly after subsequent preloading of struts. Four cases, namely, struts with full preloads, 50% preload to the first strut level, zero preload and actually observed preloads, have been adopted in the analyses to evaluate the effects of preloads. The results of the numerical analyses using the Mohr-Coulomb model are then compared with the observed wall deflection profiles in the final excavation stages. The Young’s moduli for clay and sand layers have been correlated with the soil strengths. It is found that computed peak strut loads are in agreement with the observed peak loads for the upper 3 levels of struts. For the lower 3 levels, the computed strut loads are however as much as 50% larger than those observed.

12. The twelfth paper in this volume is by Hung Jiun Liao et al on Anchors of Anchored Slopes in Taiwan: A catastrophic failure of an anchored cut slope at the national expressway in 2010 uncovered the status quo of tie-back anchors in Taiwan. Serious corrosion of anchor components due to poor corrosion protection was found to be the most obvious factor contributing to this landslide among other factors. After an extensive island-wide investigation on the existing anchored slopes, similar corrosion problem was found in many other anchored slopes. After the investigation, the construction and maintenance practice of anchored slopes had been fundamentally changed in Taiwan. This paper covers the inspection results on anchored slopes and also the measures taken to improve the corrosion protection of existing anchors and new anchors. Based on the problems found from the existing anchored slopes, some modifications on anchor tendon assembly and cement grouting practice had been developed to upgrade the corrosion protection of the new anchors and to monitor the long-term anchor load change as well.

13. The thirteenth paper is by Chiwan Hsieh et al. on Hexagonal Wire Mesh Panel Tensile Behaviour due to Weaving Patterns. The tensile engineering properties of a commonly used wire mesh (120mm x150mm, ψ=4.0mm) with triple-twist (Type A) and fourth-twist (Type B) weaving methods according to the ASTM A975 test standard are studied. Wire mesh panel tensile tests loaded in the longitudinal and transverse directions with and without centre cut wire conditions and panel connection to selvedge tests were evaluated. Generally, the longitudinal tensile strengths were higher than that for the transverse tensile strengths. The Type B panel longitudinal and transverse direction tensile strengths and connection to selvedge strengths were all greater than those for Type A panel. In addition, the Type B panel showed better strength retention rates than the Type A panel with and without centre cut wire condition. The Type B panel showed better tensile behaviour than the Type A panel.

14. Keh-Jian Shou et al. are the authors of the fourteenth paper on Trenchless Excavations for Underground Pipelines in Difficult Geology. No-Dig constructions in the city might encounter various difficulties. And the difficulties or obstacles, which might cause schedule delays and damage to the pipes. Among the others, the conditions of overcut and stuck could be the most common and critical to a pipejacking project. This study considered various difficult conditions, including different overcut range and sticking position, together with different resistance, jacking force, etc. The ABAQUS finite element software was applied for three-dimensional numerical simulations for pipe-jacking with different difficult situations. The analyses focused on the pipejacking in gravel formations, and the suggestions were concluded based on the results. The results suggest that the location of sticking and its severity (different frictional coefficient was set) affect the stress field in the pipe. And the worst condition, i.e., the totally stuck, the adjacent soil and pipe will experience excessive deformation, which must be avoided. Therefore, lubrication to avoid this extreme scenario is essential in the pipejacking operation. For the case with large diameter, unavoidable overcut and highly variable geology, the above suggestions are more crucial.

15. The fifteenth paper is by C.W. Lu et al. on Liquefaction-Induced Settlement of Structures on Shallow Foundation. Unlike the liquefaction potential assessment, the liquefaction-induced ground settlement has not been studied extensively. The uncertainty of the ground profile and associated soil engineering properties is the major challenging to advance the current knowledge on this subject. Within Ishihara and his colleagues' framework, the liquefaction-induced settlement is computed by the associated post-liquefaction volumetric strain, once the factor of safety for liquefaction is evaluated. For estimating settlement of a building with shallow foundation in liquefiable soils, on the other hand, dynamic behavior of the soils, its relative density, and the thickness of liquefiable soil, building's weight and dimensions, seismic intensity, and structure-soil interaction should be considered accordingly. This paper aims to develop a practical and simple procedure to estimate the liquefaction-induced settlement on structures on shallow foundation, based on the framework proposed by Sawicki and Mierczynski in 2009. A series of comprehensive numerical analyses were carried out to incorporate the above-mentioned factors in the developed procedure. Data of liquefaction-induced settlement of structures on shallow foundation reported in the literature were used to compared with the estimated ones.

16. Geoff Chao et al are the authors of the sixteenth paper on the Evaluation of Factors Influencing Expansive Soil Embankment Slope Failure: Slope failures in embankments constructed in expansive soils are often induced by rainfall infiltration during wet seasons or after a heavy rainfall event. Field investigations regarding the effect of rainfall infiltration on slope instability for expansive soil embankments indicate that shrinkage cracks developed during the drying and wetting cycles play an important role on the slope instability. The excessive amount of infiltration through the shrinkage cracks decreases the matric suction of the expansive soil, and hence, results in a reduction of the shear strength of the soil accompanied with soil expansion, or heave. Furthermore, the modulus of elasticity of the soil decreases as water content increases and the soil heaves. The influence of these factors on the

slope stability of expansive soil embankments is reviewed and discussed in the paper. Numerical modeling using the finite element computer programs SEEP/W and SIGMA/W was conducted to evaluate the volume change of an expansive soil embankment slope due to changes in suction arising from infiltration. Long-term stability of the expansive soil embankment slope was conducted using the computer program SLOPE/W. The expansive soil slope was also analyzed with a proposed remediation scheme to evaluate the effect of the remediation on long-term stability. The results of the numerical modeling for the slope with remediation were compared to those obtained for the slope without remediation. Furthermore, heaving of the expansive soil is accompanied by a reduction in the shear strength of the soil. Therefore, analysis of heave using the oedometer method was discussed in the paper. The results of the heave prediction using the oedometer method were compared to those obtained from the numerical modeling method. Reasons for the differences in amounts of predicted heave using both methods are discussed in the paper.

17. Strength and stiffness parameters of Bangkok clays for finite element analysis is the title of the seventeenth paper by Suched Likitlersuang, Chhunla Chheng, Chanaton Surarak and Arumugam Balasubramaniam: Constitutive soil model and its parameters are the important issue in finite element analysis. Hardening soil model and Mohr-Coulomb model parameters of Bangkok clays for finite element analysis were evaluated in this study. To achieve this purpose, a case study of Sukhumvit MRT Station was selected to model in three dimension with hardening soil and Mohr-Coulomb models. The instrumented data during construction was used to compare with the results from finite element analysis. PLAXIS 3D software was adopted as solving tool in this study. Lateral wall movement and ground surface settlement predictions were used to compare with the data. The outcomes were concluded that the hardening soil model characterized the Bangkok clay better than Mohr-Coulomb model in 3D finite element analysis for excavation.

18. The eighteenth paper is on Failure of riverbank protection structure and remedial approach by S. Horpibulsuk et al. This paper presents the case study of the collapsed riverbank protection structure along the Pasak river in Saraburi province, Thailand. The site investigation and finite element analysis using PLAXIS 2D results show that the failure occurred in sliding mode due to the natural forces. During the rainy season, water flow from the farmlands to the river by crossing the backfill of the retaining wall. Hence, seepage force was developed in the direction of the flow and induced the stability of the riverbank protection. Furthermore, the rivers and streams continuously scour the banks and undermined the natural slope, which caused the soil erosion in passive zone and resulted in instability. Based on these causes of failure, a new reinforced retaining wall structure using bored pile, geocomposite, and riprap at the front of retaining wall to protect the circular failure mechanism, seepage forces, as well as soil erosion and sedimentation, respectively was designed. The finite element verification on the new retaining wall structure showed that this structure had a sufficient factor of safety against the external and internal slope failure.

19. The last paper of this issue is the nineteenth paper is by Bergado et al on the “Development of Soft Ground Improvements Using Prefabricated Vertical Drains (PVD) and Deep Cement Mixing (DCM) Techniques”: Thailand, located on soft clay, has highly settlement. Ground improvement has become one alternative to increase soil strength, soil stiffness and reduce soil compressibility. This paper focuses on comparative performances of prefabricated vertical drain (PVD) in the improvement of soft Bangkok clay using surcharge, vacuum and heat preloading. The Vacuum-PVD can increase the horizontal coefficient of consolidation, Ch, resulting in faster rate of settlement at the same magnitudes of settlement compared to PVD. Moreover, the Thermal PVD and Thermal Vacuum PVD can increase further the coefficient of horizontal consolidation, Ch, with the associated reduction of kh/ks values by reducing the drainage retardation effects in the smear zone around the PVD which resulted in faster rates of consolidation and higher magnitudes of settlements. In addition, a new kind of reinforced method, namely: Stiffened Deep Cement Mixing (SDCM) pile is introduced to mitigate the problems of the Deep Cement Mixing (DCM) pile due to the low flexural resistance, lack of quality control in the field and unexpected failure. The SDCM pile consists of DCM pile reinforced with precast concrete core pile. The full scale embankment test on soft clay improved by SDCM and DCM piles was studied. The 3D finite element and parametric study have been investigated to understand the behavior of SDCM and DCM piles. The simulation results indicated that the surface settlements decreased with increasing lengths of the concrete core piles, and increasing sectional areas of the SDCM piles. In addition, the lateral movements of the embankment decreased by increasing the lengths (longer than 4 m) and, the sectional areas of the concrete core piles in the SDCM piles. The results of the numerical simulations closely agreed with the observed data and successfully verified the parameters affecting the performances and behavior of both SDCM and DCM piles.

20. The last paper of this issue is the twentieth paper and is by Mitsutaka Sugimoto et al on the “Study on Shield Operation Method in Soft Ground by Shield Simulation”: Shield tunneling technologies have been developed for constructing tunnels in soft ground especially under groundwater. Recently, challenging projects from the viewpoint of tunnelling technology have been planned. To realize these constructions, it is necessary to examine the shield

operation method preliminarily. The authors have developed a method to carry out the above examination and have confirmed its validity for a tunnel in stiff ground. In this research, to examine the performance of the proposed method for soft ground tunnel, the simulation on shield behaviour was carried out using the estimated shield operational data for a tunnel in soft ground. As a result, the following were found: the shield steering conditions by the proposed method are not enough to rotate the shield along a sharp curve in case of soft soil; and the simulation results have a good agreement with the planned alignment using proper shield operational data.

ACKNOWLEDGEMENT

Twenty papers are contained in this issue. Twelve of them are assembled by the Guest Editors and another eight contributed papers by the in-house editors. No doubt the material contained herein would be most valuable to our profession. The editors have adequately described the contributions in the preface. They are to be congratulated for these contributions.

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

GEOTECHNICAL ENGINEERING

June 2018:

Special Issue on 50th Anniversary of the Southeast Asian Geotechnical Society

Edited by
Noppadol Phienwej, Suttisak Soralump, Apiniti Jotisankasa, Suched Likitleruang and Tirawat Boonyatee

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Geotechnical Engineering Journal of the SEAGS & AGSSEA

Vol. 49 No. 3 September 2018

ISSN 0046-5828

GEOTECHNICAL ENGINEERING

Journal of the

SEAGS Southeast Asian Geotechnical Society

AGSSEA ASSOCIATION OF GEOTECHNICAL SOCIETIES IN SOUTHEAST ASIA

Sponsored by

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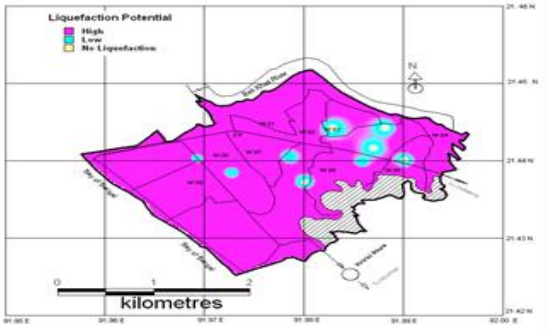

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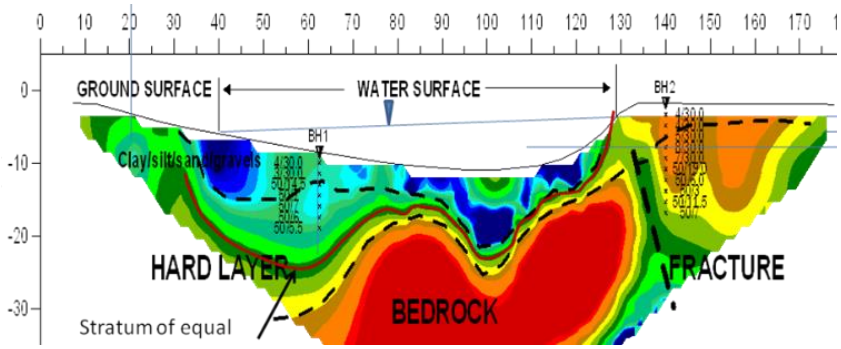

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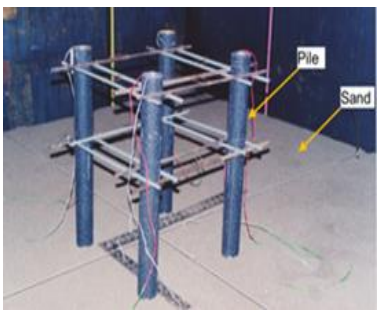

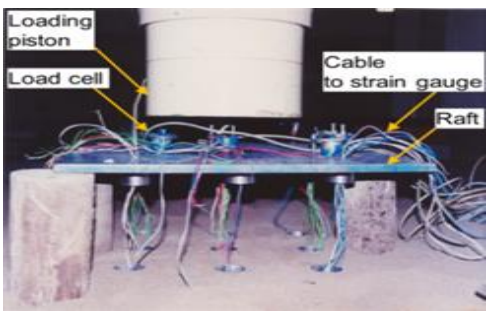

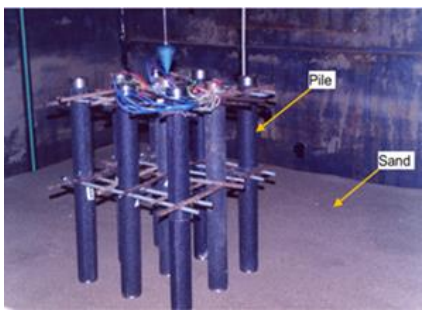

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September 2018: Contributed Papers

Edited by: Dominic Ong, San Shyan Lin & Ooi Teik Aun

Dominic Ong

Ir. Dr. Dominic Ong obtained his Bachelor's Degree in Civil Engineering from the University of Western Australia (UWA) and his PhD in Geotechnical Engineering from the National University of Singapore (NUS). Currently, he is an Associate Professor and Director of the Research Centre for Sustainable Technologies, Faculty of Engineering, Computing & Science, Swinburne University of Technology Sarawak Campus. He is also actively involved in geotechnical consultancy works within the local industry and previously in Singapore. Ir. Dr. Ong has particular interests in the fields of deep excavation, tunnelling, soil-structure interaction, ground improvement, field instrumentation works, biocementation and finite element modelling. He currently supervises 10 PhD candidates in these fields. He also holds the position of Executive Committee Member of the Association of Consulting Engineers Malaysia (ACEM) Sarawak Branch, Vice-Chairman Institution of Engineers Malaysia (IEM) Sarawak Branch and is also a Founding Member of both the Malaysian Geotechnical Society (MGS) and the Malaysian Society for Trenchless and Tunnelling Technology (MSTTT). He is also an Editorial Board Member of the UK's Institution of Civil Engineer (ICE) journal, *Geotechnical Research* as well as an Editorial Panel Member of the Southeast Asia Geotechnical Society (SEAGC)-Association of Geotechnical Societies in Southeast Asia (AGSSEA) *Geotechnical Engineering* journal. Recently, he serves in the International Society for Soil Mechanics & Geotechnical Engineering (ISSMGE) Technical Committees, namely, TC104 Physical Modelling and TC207 Soil-Structure Interaction & Retaining Walls.

San Shyan Lin

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

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

Ir. Dr. Teik Aun Ooi

Ir. Dr. Teik Aun Ooi obtained his Bachelor of Civil Engineering and Master of Engineering from Auckland Universiity in 1966 and 1968 respectively. He obtained his PhD from University of Sheffield in 1980. He was the Co - Organizing Chairman of the recently concluded SEAGC2016. He is the immediate Past President of the Southeast Asian Geotechnical Society (SEAGS), Founder Chairman of the Association of Geotechnical Societies in Southeast Asia (AGSSEA). He is a Past President of the Malaysian Institute of Arbitrators (MIArb). He is the Immediate Past ICE Country Representative for Malaysia (2000 - 2015), Founder Chairman of IEM Tunnelling and Underground Space Technical Division (TUSTD), Founder Chairman of IEM Consulting Engineering Special Interest Group (CESIG), He is an Honorary Fellow of The Institution of Engineers, Malaysia (Hon. FIEM), Fellow of the Institution of Civil Engineers (CEng FICE), Fellow of the MIArb (FMIArb), Fellow of Malaysian Society of Adjudicators (FMSA) and Fellow of Asean Academy of Engineering and Technology (FAAET). Dr. Ooi has fifty years of experience in the Construction Industry. He spent his initial fourteen years with the Public Works Department Malaysia before leaving to work in the private sector where he spent seventeen years working in the construction sector. He play major role in the Johore Baru Causeway widening and the design and construction of Senai Airport in 1970s. He was the Project manager for the Wisma Saberkas Building Project in Kuching in 1980s. He was Project Director for the Design and Construction supervision of the New Kuching Deep Water Port at Kampung Senari in 1990s. He started his consultancy practice in 2000 specialising in Civil and Geotechnical Engineering works. Dr. Ooi is a practicing Consulting Engineer, An Expert Witness in Court and in Arbitration, An Accredited Checker, An Arbitrator and An Adjudicator. He is a member of the Accredited Checker Committee of the Board of Engineers, Malaysia. Dr. Ooi devoted much of his time in honorable public service in continuing education of engineers and development of Malaysia Annexes for Eurocode 7 and 8. He is an independent executive director of IEM Training Centre Sdn Bhd since 1992. In 2013 he was appointed executive director of the IEM Academy Sdn Bhd. He has been Organizing Secretary and Chairman of numerous IEM Workshops, Seminars, and Conferences since 1970s. He was responsible for forming five active ICE Student Chapters in Universities in Kuala Lumpur. Dr Ooi conducted touring lectures in geotechnical engineering to Malaysia, Vietnam, Thailand, Cambodia, Laos, Myanmar and Philippines. In Malaysia he was invited to deliver the prestigous 19th Professor Chin Fung Kee Memorable Lecture in 2009. He frequently delivered lectures to the final year University engineering students

GEOTECHNICAL ENGINEERING

PREFACE

There are thirteen papers in this Issue: The first paper is by Hai-lei Kou and Wen-gang Zhang on Strength Characteristics of Soda Waste Treated with Fly Ash and Lime: Soda waste is a kind of industrial waste when traditional technology of soda production is adopted. The soda waste cannot be directly used as engineering soil as its low strength. However, it can be used after be mixed with other materials. In this paper, chemical materials such as fly ash and lime are used to be mixed with soda waste. The strength characteristics of soda mixtures with different ratio are studied in detail. Compaction test and unconfined compressive test are conducted respectively to assess the feasibility of these two materials. Based on test results, the mechanical properties of soda mixtures with different ratios of fly ash and lime are discussed. It is indicated that the microstructure of soda waste is similar with soil and the particle size distribution is well to mix with other materials to be used as engineering soil. The optimal ratio of soda waste and fly ash is 7:3 while the ratio is 7 % for soda waste and lime. Using the optimal ratio, the unconfined compression strength of fly ash treated soda and lime treated soda after 14 curing days is 6.5 and 6.1 times of pure soda respectively.

The second paper is by A. Puttiwongrak, K. Sam Ol1 and V. Sakanann on Groundwater Recharge Estimation in Kathu, Phuket using Groundwater Modelling: Kathu is a district of Phuket Island in Thailand, and is the district with the largest number of communities in Phuket. Groundwater is the main water supply on Phuket. Urbanization is occurring very rapidly on Phuket and this has stimulated water demand at an accelerating rate. A lack of fresh water and the results of over-use of groundwater could be serious problems in Phuket in the near future. The study described in this paper simulated groundwater recharge flux in Kathu, using groundwater modelling to estimate groundwater recharge. The simulation was carried out across the locations in Kathu for the period, 2006-2016. Historical Groundwater well data were collected and used to create a groundwater model. The trial and error method was applied to the recharge flux to obtain matches between simulated and observed groundwater heads or levels within acceptable ranges of error. Finally, it was concluded that the groundwater recharge in Kathu is currently able to maintain the groundwater level, although groundwater has been withdrawn at a highly accelerating rate, especially between 2012 and 2016. The positive trend in the recharge rate can be attributed to increasing efficiency in the use of water catchment areas, high rainfall, and rising sea levels.

In the third paper, A. Imtiaz, A. Barua, M. Sakib and M.A. Ansary; describe Seismic Microzonation of Cox's Bazar Municipal Area Bangladesh: Cox's Bazar municipal area runs a high risk of earthquake exposure due to geologic and tectonic structures. As a part of adopting earthquake mitigation approaches for the region, a seismic microzonation map was developed on the basis of potential of earthquake occurrences and ground susceptibility to earthquake. For microzonation purposes, a total of 26 borelogs were used to study site amplification as well as soil liquefaction potential of the municipality area. Site responses were estimated through one dimensional wave propagation software SHAKE. The liquefaction potential was evaluated using two simplified procedures, proposed by Seed et al. (1983) and Iwasaki et al. (1986) to measure whether the site is liquefiable or non-liquefiable. For slope stability analysis, XSTABL programme was used which performs two dimensional limit equilibrium analyses to evaluate the factor of safety for a layered slope using the simplified Bishop Method. These results were transformed into a map which will serve as a general guide to ground-failure susceptibility, effective land use, and efficient town-planning.

In their paper (fourth one), M. R. Selamat, A. Shafie, R. Saad, and M. M. Nordiana on Geophysical Investigation in Bukit Merah Reservoir : The suspected cavity presence in the bedrock of the outlet canal of Bukit Merah Reservoir in Malaysia raised concern that it could undermine the integrity of a check pier structure planned just ahead of the spillway. Boring into a cavity could also compromise reservoir containment capacity. A seismic refraction and electrical resistivity tomography carried out for the

subsurface section spanning the two banks revealed not only the presence of a relatively porous zone towards one end but also the undulating material boundaries towards the other. The results called for review of the original foundation of the check pier structure involving bore piles of equal length. The suspected porous zone was avoided in the renewed bore pile design while the bedrock depressions were appointed with deeper bores for adequate pile embedment. The design review resulted in piles resting on a stratum of equal geotechnical quality with each new pile now having a different length.

The fifth paper is on Effect of Ground Disruption on the Strength of Gatch Soil in Kuwait by Ziad Abdelsalam and Nabil Ismael: Kuwait soil is commonly known as 'Gatch' and classified as very dense cemented sand Kuwait sand has sulphates and calcium carbonated in form of gypsum components that caused cementation bonds with environment aids such as highly evaporation of rainfall in winter season. This soil is used as a backfill material and it is important to know the effect of excavation and recompaction on the strength characteristics. The present study provides experimental results on the effect of ground disruption on strength parameters of cemented sand in Kuwait, such as they are the cohesion c, and the angle of friction ϕ' and stress strain characteristics. The triaxial test was used to determine these parameters on undisturbed and remolded specimens at different depths. The results show a disturbance of cemented sands cause loss of the cohesion component of strength and a minor reduction in the angle of shearing resistance.

In the sixth paper is on Greenheart Timber Strip Reinforcement for Reinforced Soil Retaining Walls by Sean A. Surujdas and C.N.V. Satyanarayana Reddy: This article presents the result of investigating the feasibility of using greenheart timber strips as reinforcement for reinforced soil retaining walls in Guyana. The work is intended to assess the cost economics between greenheart timber strips and geogrids as reinforcements. Medium grained river sand is used as fill material in reinforced soil retaining wall designs. The interfacial friction between greenheart timber and fill material is determined by the laboratory pullout test. The designs of reinforced soil retaining wall revealed that Greenheart timber strips of 350mm width and 25mm thickness are sufficient to reinforce retaining wallswith backfill of heights 4m and 6m, while greenheart timber strips of 350mm width and 50mm thickness are sufficient to reinforce retaining walls with backfill of heights 8m and 10m. It is observed that as height of retaining wall increases from 2m to 10m, the percentage cost saving of using greenheart timber strips as compared with geogrids, increases from 10% to 24%.

In the subsequent seventh paper in the series Yudhi Lastiasih and Herman Wahyudi present the HWYL Method for Predicting Settlement of Soft Soil: The HWYL method is one of the analytical methods for predicting the amplitude and time of settlement that occurs, based on the field observations using a settlement plate or extensometer. The data used for the analysis was the result of observations from a settlement monitoring instrument of some road embankment and reclamation projects on soft soil in Indonesia. The data was analyzed using a statistical approach to determine the behavior and correlation of settlement amplitude versus time curve shape. This method obtains an equation formula to predict the consolidation amplitude and when the final settlement of last embankment occurred.

Sengara, IW., Roesyanto, Krisnanto, S., Jayaputra, A. A., and Irsyam, M. in the eighth paper deal with Bearing Capacity and Settlement Study on Small-Scale Piled-Raft Groups in Sand: Pile group foundation with a pile cap can be considered as a piled-raft foundation. Previous studies indicate that in a piled-raft foundation, the piles contributes to reduce settlement of the raft whereas the raft provides an additional bearing capacity of the pile group. Laboratory testings were performed to investigate the performance of piled-raft group from bearing capacity and settlement point of views. Instrumented laboratory models of 2x2 and 3x3 piled-raft group were loaded vertically to obtain load vs. settlement curves and load-transfer to raft, to pile shaft, and to pile tip. From the load-settlement curves of piled-raft group, the performance of bearing capacity and settlement was then observed and quantified. The laboratory test results indicated that the presence of piles reduced the settlement of raft significantly, whereas the presence of raft provided additional bearing capacity to the pile.

In the ninth paper the Influence of Two Rough Parallel Joint Surface Profiles on Stress Wave Energy Dissipation is described by Yexue Li,; Hongke Pan, Li Qinand Jianhui Fan: A new method called YUV dimension is proposed to describe joint surface configuration on the basis of the interdisciplinary theory of iconography, graphics, and fractal geometry. This method can be used as substitute for traditional fractal dimensions. On this basis, the influence of two joint surface profiles (described by using the YUV dimension method) on stress wave energy dissipation is investigated by split Hopkinson pressure bar on embedded rough parallel two-joint rocks. The following conclusions are drawn: (1) the YUV dimension method, a new approach for characterizing surface configuration, exhibits more advantages than the traditional dimension; (2) the energy dissipation of the joints increases with increasing two-joint dimensions or their sums. This increase is attributed to the fact that the increase in YUV dimensions leads to the decrease in rock joint stiffness; thus, a decrease in rock joint stiffness leads to the increase in stress wave energy dissipation. A nonlinear relationship also exists among two YUV dimensions and energy dissipation. The nonlinear relationship is attributed to the nonlinear deformation of the joints. For engineering applications, a two-variable function between the energy dissipation and YUV dimensions of two joints is also formulated

Wang Ning, Zhou Xiaolong and Zhu Dengyuan are the authors of the tenth paper on Failure mode for creep area of high open-pit slope under the influence of underground mining: With mining intensity increasing, more and more deep open-pit mines are gradually transformed to underground mining in China nowadays. Focusing on high open-pit slope under the influence of underground mining, the spatial distribution and development trend of slope displacement monitoring data were analyzed, combined with calculation of slope stability under different engineering conditions. The results show that the slope deformation has a periodic change with the seasons, and the rainy season is the most intense period of deformation development, when the tensile cracks on the top platform of the slope become seepage channel for rainwater. The slope stability coefficient of the creep area under the drainage condition is 1.010 and the most dangerous sliding surface is located in the upper part, whereas sliding zone is obviously reduced compared to saturated condition and dangerous sliding surface also decreases, and reasonably slope cutting can largely improve the slope stability. By studying the deformation process of high open-pit slope, the deformation development characteristics and possible failure modes are got, and it could provide guidance to the reinforcement measures of landslides and ground subsidence.

The eleventh paper b Nabil Ismael and Hasan Al-Sanad is on the Properties of Desert Sands Reinforced with Ground Tire Rubber in Kuwait: The abundance of waste tires in Kuwait created a major problem requiring disposal sites and causing environmental and safety problems especially in the summer months as the temperature often exceeds 50□C. Numerous fires have occurred causing air contamination and health hazards. To find useful uses of ground tire rubber an extensive laboratory testing program was carried out using rubber aggregates produced locally as additive in small quantities up to 20% by weight to the local surface sands of Kuwait. Testings included grain size, unit weight, Modified Proctor compaction, permeability, direct shear, consolidation, and CBR tests. The effect of increased rubber content on the different properties was measured. The results indicate a reduction of the density and CBR, an increase in the permeability and compressibility and no change in the angle of friction □ with increasing rubber content. Therefore, the use of rubber additive is beneficial for many practical applications such as light weight fill, as a drainage layer, and on the grounds of sporting facilities, and in embankment construction.

The twelfth on a study on behavior of vertical pile in sand under uplift load by R. Saravanan and P.D. Arumairaj: The significant design parameter for supporting the piles and the ground anchors for tension loads and compressive loads is shaft resistance. Steel pipe piles often mentioned as cylindrical piles are used often in offshore projects and in harbor structures. Since the end condition of the cylindrical piles (open and closed end) plays a significant change in the shaft capacity of the pile, an experimental study is proposed to predict the load displacement characteristics of single vertical pile subjected to uplift load. The pile is embedded in sand with varying relative densities. The analytical study was developed based on the failure mechanism from limit equilibrium technique. The present study takes into account of

significant parameters such as length, diameter and as surface characteristics of pile. The axial load-displacement behavior of vertical pile is studied under the different length to diameter (L/d) ratio which is adopted for the experimental analysis. The uplift co-efficient (Ku) is evaluated by using ultimate uplift capacity load. The obtained experimental results were compared with the reported data to elucidate the significance of the work done.

The last paper of this issue is the thirteenth paper on Numerical Simulations of K0 Triaxial Tests on Collapsible Porous Clay by J.C. Ruge, A. López, F.A. Molina-Gómez, R.P da Cunha and J.E. Colmenares: This paper addresses numerical simulations of K0 triaxial tests performed using a single element program. The methodology was based on construction of numerical models with three different constitutive models in order to represent the soil behaviour during stress path states. The constitutive models used were (i) the Mohr-Coulomb, (ii) the Cam-Clay, and (iii) a hypoplastic model. The material used was a collapsible porous Brazilian clay. The values obtained were compared and calibrated with experimental data. Results show that it is possible to assess soil behaviour via a single element program and that triaxial K0 stress path tests can be simulated with numerical methods. Results show that it is possible to replicate and calibrate soil behaviour under zero lateral displacement using computational tools.

Editors:
Dominic Ong
San Shyan Lin &
Ooi Teik Aun

ACKNOWLEDGEMENT

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

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

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September 2018: Contributed

Edited by
Dominic Ong, San Shyan Lin & Ooi Teik Aun

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Geotechnical Engineering Journal of the SEAGS & AGSSEA

Vol. 49 No. 4 December 2018

ISSN 0046-5828

GEOTECHNICAL ENGINEERING

Journal of the

SEAGS Southeast Asian Geotechnical Society

AGSSEA ASSOCIATION OF GEOTECHNICAL SOCIETIES IN SOUTHEAST ASIA

Sponsored by

AIT Asian Institute of Technology

Indexed by EI since 1970 Scopus since 2001 ESCI since 2017

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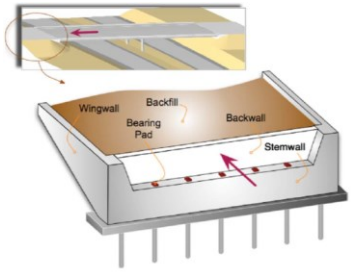

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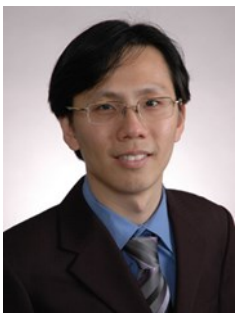
Edited by: SUJIT KUMAR DASH (LEAD EDITOR), ALFRENDO, DARREN CHIAN & SAN SHYAN LIN

Sujit Kumar Dash

Dr. Sujit Kumar Dash is currently a faculty member in the department of civil engineering, Indian Institute of Technology Kharagpur, India. He is a geotechnical engineer by profession and obtained Ph.D. for his work on geocell reinforced foundations, in the year 2001, from the Indian Institute of Technology Madras. He was a visiting fellow at the Technical University of Munich, Germany and University of Wollongong, Australia. He has received the German Academic Exchange Service Fellowship and the Australian Endeavour Research Fellowship. Dr. Dash has published more than 80 papers in various journals and peer reviewed conference proceedings. His papers on geosynthetics and allied construction products have received the Indian Geotechnical Society best paper award.



Siau Chen Chian (Darren)

Dr. Chian is an Assistant Professor at the Department of Civil and Environmental Engineering, National University of Singapore. He received his PhD and BEng with gold medal from Cambridge University and Nanyang Technological University respectively. His research interests are in earthquake engineering and ground improvement. Dr. Chian's contribution in earthquake engineering lies in the field of damage vulnerability of underground structures in earthquake induced soil liquefaction. He was funded by the UK Engineering and Physical Sciences Research Council (EPSRC) to carry out reconnaissance missions at the 2009 Padang, 2011 Tohoku and 2016 Muisne earthquakes. Dr. Chian is also an enthusiast of recycling waste material to good use. He is actively involved in collaborative research projects with local government agencies to recycle unwanted and contaminated soils from underground construction projects and sea dredging as construction and fill materials. He is a nominated member of three International Technical Councils under the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE). Dr. Chian also sits in the technical committee of SPRING Singapore to oversee and provide advice on geotechnical engineering practices in Singapore. He is presently the Vice President of the Geotechnical Society of Singapore (GeoSS). Dr. Chian has been invited to speak in a number of international conferences in Singapore, Malaysia and India. Recently, Dr. Chian's research work at NUS led to his award of the prestigious Top 10 Innovators Under 35 in Asia by the MIT Technology Review in 2016. Other achievements include a 1st Prize in a National Technical Paper Competition and the Best Young Researcher Award at the 8th International Conference on Urban Earthquake Engineering.

Alfrendo Satyanaga

Dr Alfrendo Satyanaga is currently a Senior Research Fellow at School of Civil and Environmental Engineering, Nanyang Technological University, Singapore. He has over 15 years of civil engineering experience as a geotechnical engineers, consultant and researcher in design, mathematical and numerical modelling as well as laboratory testing. His area of expertise includes unsaturated soil mechanics, slope stability analysis, foundation design, site investigation and soil characterization, geotechnical instrumentation and finite element analyses. He has served as a consultant on various projects to several engineering firms in Singapore, Australia and Indonesia. Dr. Alfrendo holds PhD degree from the Nanyang Technological University, Singapore and Master degree from the Newcastle University, United Kingdom. He has published and presented more than 40 technical papers in international journals and conferences. For innovation in developing a new system to optimize space and improve the liveability in Singapore using urban greenery, Dr Alfrendo has been conferred "the Minister(ND)'s R&D Award (Special Mention Category)" in June 2017.

San Shyan Lin

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

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

GEOTECHNICAL ENGINEERING

PREFACE

There are 16 papers in this Issue; the first paper is by Akshay Kumar Jha, M.R. Madhav and GVN Reddy on Analysis of Effect of Reinforcement on Stability of Slopes and Reinforcement Length optimization: Steepening of slopes for construction of rail/road embankments or for widening for other civil engineering structures is a necessity for development. Use of geosynthetics for steep slope construction or repair of failed slopes considering all aspects of design and environment could be a viable alternative to these problems. Literature survey indicates that efforts are being made for optimization of length of reinforcement for overall economy. The present paper details an analysis to optimize the length of geosynthetic reinforcement from the face or near end of the slope with respect to its location to obtain the desired minimum factor of safety. Unreinforced and reinforced slopes are analyzed using Morgenstern-Price method to obtain critical factors of safety. The effect of providing geosynthetic reinforcement layer in shifting the critical slip circle has been identified and quantified. Consequently relatively smaller magnitude of force gets mobilized in the reinforcement.

The second paper is by V. Vinay Kumar and S. Sireesh on Fatigue Performance of Geosynthetic Reinforced Two-Layered Asphalt Concrete Beams: One of the most common rehabilitation techniques adopted for distressed pavements is hot mix asphalt (HMA) overlay. It is often practiced to include geosynthetic interlayers before placing an HMA overlay. The interlayers in HMA overlay not only improves the performance life of the pavement structure by increasing the stiffness, but also, reduces the maintenance cost and the cost of construction by reducing the thickness of HMA overlay. In the current study, the performance of geosynthetic reinforced two layered asphalt beams is evaluated in two stages. During the first stage, the fatigue performance of the two layered asphalt beams is evaluated using a flexural fatigue test (four point bending). During the second stage, the fracture energy required for crack propagation in the beams during fatigue loading and the corresponding tensile stiffness of two layered asphalt beams with and without geosynthetic interlayers are determined using Fenix test. Three types of geosynthetics, namely biaxial polyester grids, woven geo-jute mat and biaxial polypropylene grids are used in the study. The results from fatigue and Fenix tests indicated that the fatigue life and the tensile stiffness of the geosynthetic reinforced asphalt beams have drastically increased against the control specimens. A 30 times increase in fatigue life is noticed in polyester grid reinforced asphalt beams against unreinforced beams at 10 mm vertical deformation, which is attributed to the increase in tensile stiffness of the specimens from 7.3 kN/mm to 17.6 kN/mm. A linear regression equation is proposed to correlate the normalized complex modulus and tensile stiffness index to estimate the complex modulus of the geosynthetic reinforced asphalt beams.

The third paper by Priti Maheshwari and G. L. Sivakumar Babu is on Deformation Response of Geocells in Pavements under Moving Loads**:** Geocells are extensively used in pavements as one of the ground improvement techniques. Pavements are subjected to various types of loading pattern and its deformation under these loads plays an important role in its analysis and design. In the present work, a deformation model of geocell has been proposed in which geocell has been idealized as an infinite beam subjected to a concentrated load moving with constant speed. The foundation soil has been modeled as Winkler springs. Influence of magnitude and speed of applied load, flexural rigidity of geocell, modulus of subgrade reaction of foundation soil, mass of beam, viscous damping and interfacial resistance between geocell reinforcement and the neighboring soil on response of geocell has been studied. Non-dimensional charts have been developed for normalized deflection and the bending moment in geocell reinforcement. These charts will be useful while analyzing and designing the pavements under moving loads. A numerical example has also been presented for the better understanding of results from the proposed model.

In the paper (fourth one) by K. Deb on Effect of Multilayered Geosynthetic Reinforcements on the Response of Foundations resting on Stone Column-Improved Soft Soil**:** The present paper pertains to the development of a mechanical model based on soil-structure interaction to study the effect of multilayered

geosynthetic reinforcements on the behaviour of footings resting on stone column-improved soft soil. The footing is idealized as a beam. The soft soil and granular layer are idealized as nonlinear spring-dashpot and Pasternak shear layer, respectively. The geosynthetic reinforcements are modelled by elastic membranes. The stone columns are idealized by nonlinear springs. The governing differential equations are solved by finite difference method and results are presented in non-dimensional term. It is observed that multilayered-reinforced system is not effective for settlement reduction, but it is effective for bending moment and shear force reduction. However, for higher modular ratio (>40), the multilayered-reinforced system is not useful for maximum bending moment reduction. As the modular ratio increases positive bending moment at the centre of the beam decreases and the positive bending moment of the beam above middle of the stone column becomes negative. The negative bending moment of the beam above middle of the stone column increases as the modular ratio increases. The maximum shear force is observed for s/b_w ratio 3 and 5 corresponding to the modular ratio 10 and 100, respectively.

The fifth paper is on A Critical Review of the Performance of Geosynthetic-Reinforced Railroad Ballast by Syed Khaja Karimullah Hussaini, Buddhima Indraratna, and J. S. Vinod: In the recent times, railway organizations across the world have resorted to the use of geosynthetics as a low-cost solution to stabilize ballast. In this view, extensive studies have been conducted worldwide to assess the performance of geosynthetic-reinforced ballast under various loading conditions. This paper evaluates the various benefits the rail industry could attain because of the geosynthetic reinforcement. A review of literature reveals that geogrid arrests the lateral spreading of ballast, reduces the extent of permanent vertical settlement and minimizes the particle breakage. The geogrid was also found to reduce the extent of volumetric compressions in ballast. The overall performance improvement due to geogrid was observed to be a function of the interface efficiency factor (α). Moreover, studies also established the additional role of geogrids in reducing the differential track settlements and diminishing the stresses at the subgrade level. The geosynthetics were found to be more beneficial in case of tracks resting on soft subgrades. Furthermore, the benefits of geosynthetics in stabilizing ballast were found to be significantly higher when placed within the ballast. The optimum placement location of geosynthetics has been reported by several researchers to be about 200-250 mm below the sleeper soffit for a conventional ballast depth of 300-350 mm. A number of field investigations and track rehabilitation schemes also confirmed the role of geosynthetics/geogrids in stabilizing the tracks thereby helping in removing the stringent speed restrictions that were imposed earlier, and enhancing the time interval between maintenance operations.

In the sixth paper on the Performance of Geosynthetic Reinforced Model Pavements under Repetitive Loading is by K. H. Mamatha, S. V. Dinesh and B. C. Swamy: In this paper, the effectiveness of geosynthetic reinforcement materials such as geogrids and geocells in improving the pavement performance is investigated by carrying out a series of repeated load tests on unreinforced, geogrid and geocell reinforced model pavement sections. The effect of properties of geogrids and geocells on the improved performance is also studied. The provision of geogrid/geocell at the interface of subgrade and sub-base course is found to reduce the plastic settlement significantly with geocells being very effective when compared with geogrids. The reduced plastic settlement results in reduced rutting at the surface leading to increased service life of the pavements and also increased ride comfort to the road users. The geocells reinforcement results in higher TBR values when compared with that of geogrid.

The seventh paper by M. Ramalakshmi and G. R. Dodagoudar is on Lateral Response Analysis of GRS Bridge Abutments under Passive Push: The objective of this study is to analyse the response of Geosynthetic Reinforced Soil (GRS) bridge abutments under lateral push towards the backfill. Hypoplastic constitutive model is adopted as the user defined material model in the subroutine, VUMAT, to represent the soil behaviour in finite element (FE) analysis. The unreinforced abutment and GRS abutments of eighteen different configurations are modelled using FE approach and analysed for static passive push up to a maximum lateral displacement of 0.3 m. The passive force-displacement curves are obtained to study the lateral response of the GRS abutments. The curves for different GRS configurations lie closer to each other up to a lateral displacement of 0.1 m, beyond which their passive resistances vary. The GRS abutments with

geogrid spacing, s = 0.2 m and geogrid length to abutment height ratio, L/h = 3 performed well as compared to the other cases.

The subsequent paper eight in the series is by H. Venkateswarlu and A. Hegde on Numerical Analysis of Machine Foundation Resting on the Geocell Reinforced Soil Beds: The foundation beds are often subjected to dynamic loads due to many circumstances, such as earthquakes, traffic loads, and the machine vibrations in the case of the machine foundations. Excessive vibrations caused by the dynamic sources can lead to the structural damage of the foundation soil. Over the years, geosynthetics have been effectively used in reducing the settlement of the foundations under static loads. However, the performance of geosynthetics is not fully analyzed under the dynamic loads. In the present study, the numerical analyses have been carried out to understand the performance of the machine foundations resting on the geocell reinforced beds. The analyses were carried out by using finite element software PLAXIS 2D. The hypothetical case of the circular machine foundation of 1 m diameter resting on the saturated silty sand was analyzed. Mohr-Coulomb failure criteria was used to simulate the behavior of the soil. Initially, the numerical model was validated with the existing results reported in the literature. The validated numerical model was further used to investigate the performance of the machine foundations. Three different cases, namely, unreinforced, geogrid reinforced and geocell reinforced were considered. The response of all the cases was studied by varying the frequency of dynamic excitation and maintaining the constant force amplitude. The depth of the placement of the geocell and geogrid was also varied. At the optimum location of geocell, 61% reduction in the displacement amplitude was observed as compared to unreinforced foundation bed. Similarly, as compared to geogrid, more than 50% reduction in the displacement was observed in the presence of geocell. In addition, 40% reduction in peak particle velocity was observed in the presence of geocell at the center of the footing. The resonant frequency was found to vary with the reinforcement system. Furthermore, 163% increase in the damping ratio of the soil was observed in the presence of geocell. In this way, the study highlights the possible new applications of geocell in supporting the machine foundations.

B. Giridhar Rajesh, S. K. Chukka, and A. Dey are the authors of the ninth paper on Finite Element Modelling of Embankment Resting on Soft Ground Stabilized with Prefabricated Vertical Drains: This paper presents the numerical modelling of embankment resting on soft soil improved by the use of prefabricated vertical drains (PVDs). The study has been validated with the field measurements of settlements and excess pore pressures for a trial embankment at the Krishnapatnam Ultra Mega Power Project (KUMPP) in Nellore, Andhra Pradesh, India. The paper elaborately highlights the intricate effect of various parameters such as the drain spacing, reduction of permeability due to smear, and the efficiency of floating drains. Two dimensional finite element modelling was carried out using PLAXIS 2D. In the analysis, classical axisymmetric solution for consolidation by vertical drains has been converted into an equivalent two-dimensional plane strain analysis. The comparatives reflect the agreements and differences between the field measurements and the results obtained from the numerical model. Based on the results, the state of smear prevailing in the field has been identified. The numerical study suggests that the optimal length of the partially penetrating drains (75-80% of the full penetration) would be efficient in aiding sufficient vertical consolidation of the soft soil site, thus making its usage more economical.

The tenth paper is by H. Rahardjo, N. Gofar, F. Harnas and A. Satyanaga on Effect of Geobags on Water Flow through Capillary Barrier System: Capillary barrier is a two-layer cover system consisting of fine over coarse materials designed to protect slope from rainfall-induced failure. Previous studies have shown that the capillary barrier system (CBS) is effective for protection of gentle slopes, but the application of CBS on steep slopes requires further study. The fine materials are wrapped with geobags before laying them on top of the coarse materials. In this case, the bags serve as the separator between the fine and coarse materials. This paper highlights the effect of geobags on the effectiveness of CBS consisting of fine sand (Sand) as the fine material and reclaimed asphalt pavement (RAP) as the coarse material. Soil column tests were performed for two configurations (1) Sand overlying RAP (no-geo) and (2) Sand overlying RAP with geobags inserted at the interface (geo). The soil column was instrumented with tensiometer-transducer system, moisture sensors and electronic balance to measure pore-water pressures (PWP), volumetric water content (VWC) and outflow, respectively. Numerical simulations were carried out to support the findings from the soil column tests. Results of the soil column tests and numerical analyses on both configurations

showed that the presence of geobags at the interface of Sand and RAP does not affect the effectiveness of CBS as slope protection from rainfall infiltration.

Sanjay Nimbalkar, Sujit Kumar Dash, and Buddhima Indraratna are the authors of the eleventh paper on Performance of Ballasted Track under Impact Loading and Applications of Recycled Rubber Inclusion: In this paper a review of the sources of impact loads and their effect on the performance of ballasted track is presented. The typical characteristics and implications of impact loading on track deterioration, particularly ballast degradation, are discussed. None of the procedures so far developed to design rail track incorporate the impact that dynamic loading has on the breakage of ballast and therefore it can be said to be incomplete. An intensive study on the impact of induced ballast breakage is needed in order to understand this phenomenon and then use the knowledge gained to further advance the design methodology. A stiff track structure can create severe dynamic loading under operating conditions which causes large scale component failure and increases maintenance requirements. Installing resilient mats such as rubber pads (ballast mat, soffit pad) in rail tracks can attenuate the dynamic force and improve overall performance. The efficacy of ballast mats to reduce structural noise and ground vibration has been studied extensively, but a few recent studies has reported how ballast mats and soffit pads reduce ballast degradation, thus obviating the necessity of a comprehensive study in this direction.

12th in the series is the paper, Probabilistic Stability Analyses of Reinforced Slope Subjected to Strip Loading, by Koushik Halder and Debarghya Chakraborty. Studied herein is the effect of uncertainty associated with soil friction angle (ϕ) and soil unit weight (γ) on the stability of unreinforced and reinforced cohesionless soil slopes subjected to strip loading. The magnitude of CoV of ϕ and γ are varied to account uncertainties. The location of the footing on the top of the slope is also changed. Stability of both unreinforced and reinforced slopes is presented in terms of factor of safety (FoS). Deterministic FoS values are computed first by using a two-dimensional finite difference software FLAC. To perform probabilistic analyses, FLAC is combined with Monte Carlo simulations. The outcomes of the probabilistic analyses are presented in terms of probability of failure (p_F) and reliability index (β). The value of β obtained from the present study is compared with the guidelines provided by USACE. It is found out that with the increase in the value of CoV, p_F increases and β decreases. The failure probability of slope is found to be maximum, when footing is placed on the edge of the unreinforced slope. With the inclusion of a single layer of geotextile in the slope for the same footing position, p_F reduces drastically, and β increases significantly. As footing position shifts from the slope edge, p_F increases for a particular CoV value of ϕ and γ. The effect of uncertainty related to ϕ is found to be more prominent with compared to the uncertainty related to γ. The influence of cross-correlation between ϕ and γ is also studied. It is found that there is no significant change in the value of p_F with the change in the value of cross correlation coefficient. Though the present study is related to a simple slope stability problem, but using the same methodology, probabilistic analyses of complex slopes can also be performed.

The 13th paper by J. Scalia IV, C.A. Bareither, and C.D. Shackelford is on Advancing the Use of Geosynthetic Clay Liners as Barriers: Geosynthetic clay liners (GCLs) are effective barrier materials for liner and cover systems in waste containment applications. Exposure to non-standard chemical solutions can alter the chemical and mechanical properties of both the bentonite and geotextiles comprising a GCL. Considerable advances in laboratory testing and analysis of GCLs have occurred recently in regard to hydraulic conductivity, the existence and persistence of membrane behavior, and long-term shear strength of GCLs evaluated under stress-controlled conditions. The objective of this paper is to present a synopsis of advances in research related to GCLs that is focused on enhancing knowledge of GCLs used as hydraulic and chemical contaminant barriers.

G. Bräu and S. Vogt are the authors of the 14th paper on Field and laboratory tests on the bearing behaviour of unpaved roads reinforced by different geosynthetics**:** Field experiences have shown that the use of geosynthetics improves the trafficability of unpaved roads on soft subsoil. Furthermore, the height of the base course and therefore the amount of high quality geomaterials e.g. crushed gravel can be reduced. Until now, the design is mainly based on empirical approaches. The height of the base course is increased until the

unpaved road reaches a proper bearing behaviour or it is decided to use a certain base course height that gives mostly conservative results. There are plenty of examinations shown throughout the literature, confirming the principle of bearing mechanism but mostly cover only individual effects. Therefore, they cannot be extended to an overall theory and design approach that account for all important variables. In a completed research, series of loading tests on geotextile reinforced unpaved roads were carried out both in laboratory and in field. Beside the bearing strength and stiffness respectively of the soft subsoil, the base course height as well as the type and hence strength of the geosynthetics were varied in the test series. This paper presents a brief summary of the experimental results that may be used to evaluate models that aim for the prediction of the bearing capacity of unpaved roads.

The fifteenth paper is by Maria P.S. Susunaga, Ennio M. Palmeira & Gregório L.S. Araújo on Performance of nonwoven geotextiles as separators for pavement applications**:** Geosynthetics can be used in several applications in geotechnical and geoenvironmental engineering, being geotextiles the most traditional and versatile type of geosynthetic. One of the applications of geotextiles is in separation between good and poor quality soils. This situation may occur in geotechnical structures such as roads and railways constructed on soft saturated subgrades. The presence of a geotextile separator avoids or minimize the contamination of the good quality base or ballast material with fines from the subgrade, increasing the life of the road and reducing maintenance costs. Despite its importance, very few studies on the behaviour of geotextiles in separation can be found in the literature compared to other applications of these materials. This paper investigates the performance of nonwoven geotextiles in separation. Laboratory tests on geotextiles with masses per unit area ranging from 200 g/m^2 to 600 g/m^2 were executed using an apparatus capable of applying repetitive loading to simulate traffic conditions. Measurements of surface displacements and pore pressures in the subgrade soil and the evaluation of geotextile mechanical damages at the end of the tests were carried out. The results obtained showed that the geotextiles were effective separators, avoiding contamination of the base soil and accelerating the dissipation of excess pore pressures in the subgrade soil.

The sixteenth and also the last paper of this issue is on Geosynthetics Application in Indonesia –Case Histories by Tjie-Liong GOUW. In Indonesia, the first application of geosynthetics technology was back in 1983, where a high strength geotextile of 200 kN/m was laid to help stabilize the highway built on swampy land toward Soekarno Hatta airport, the gateway to Indonesia. Since then, geosynthetics have been gaining popularity in solving challenging ground conditions for civil engineering development, e.g. stabilization of road development over peat deposits, accelerating consolidation of soft clay, stabilization of foundation over expansive clays, slope stabilization over clay shales formation, retaining walls, ponds lining, breakwater, shore protection and river bank stabilization, etc. This paper presents the author experiences in applying geosynthetics technology in building geotechnical construction over difficult ground condition such as peat, soft clay, expansive soils, and clay shales. It also presents the application of geosynthetics tubes (geotubes) to build containment dykes over soft marine clays.

ACKNOWLEDGEMENT

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

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

GEOTECHNICAL ENGINEERING

December 2018:

Edited by

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