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Editors: Prof. Zhen-Yu YIN and Prof. Jian-Hua YIN

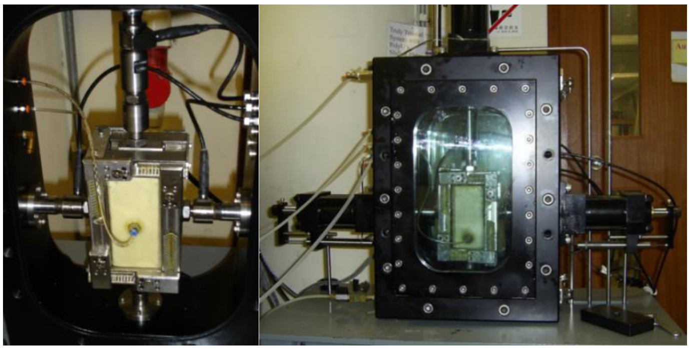
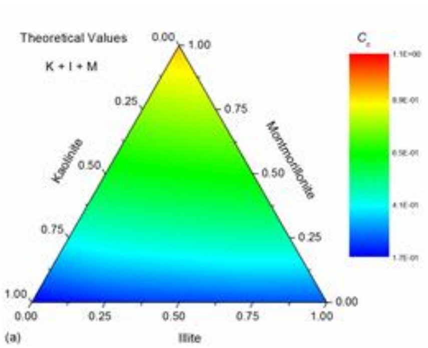


Photo 1 (a) Details of true triaxial loading and
(b) the water proof chamber (After Yin at al, 2010)



(a) Compression test

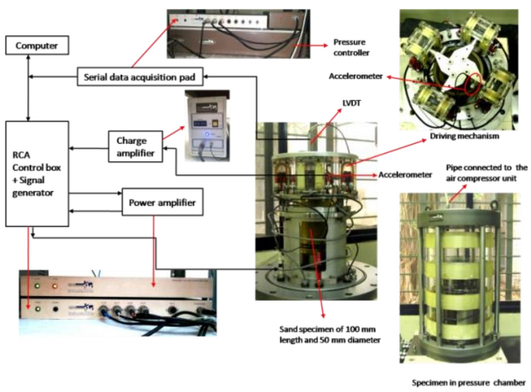
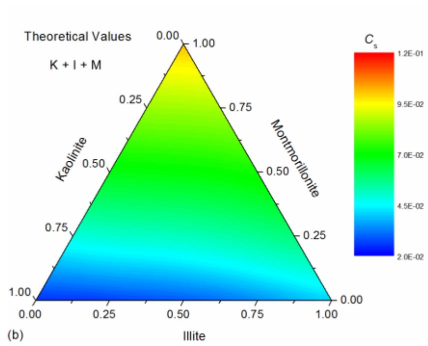


Photo 2 Resonant column apparatus
(After Kumar and Cherian, 2015)



(b) Swelling index

Photo 3 Triangle plot of theoretical results for mixtures of Kaolinite, Illite and Montmorillonite (After Ye et al, 2015)

GEOTECHNICAL ENGINEERING

September-2015 Issue: Soil Behaviour and Modelling

Edited By Prof. Zhen-Yu Yin and Prof. Jian-Hua Yin

Prof. Zhen-Yu Yin

Prof. Yin graduated from Zhejiang University, China in 1997 for his bachelor degree and from Ecole Centrale de Nantes, France in 2003 for his master degree. He got PhD from Ecole Centrale de Nantes, France in 2006 in the field of geotechnical engineering. He was promoted as professor in 2010 at Shanghai Jiao Tong University in China. Prof. Yin's research topics include: (1) constitutive modeling for saturated soils; (2) microstructure and micromechanics for soils; (3) improvement technology for soft soils; (4) finite element analysis for geotechnical engineering. He has authored more than **50** papers in peer review journals such as Geotechnique, ASCE journals, IJSS, Nag etc.

In 2011, Prof. Yin was awarded "Professor of Exceptional Rank of Shanghai-Dongfang Scholar" by Shanghai Education Committee. Prof. Yin is now serving as committee member for both national and international associations (granular materials committee ASCE, Constitutive Relation and Strength Theory Committee of Chinese Society of Soil Mechanics and Geotechnical Engineering, Soil Mechanics Committee of Chinese Society of Theoretical and Applied Mechanics, Underground Engineering Committee of Shanghai Society of Civil Engineers). From 2010 up to 2012, Prof. Yin has received 8 research grants as main investigator, financed by European Union, Chinese National Science Foundation, Minister of Education of China, Shanghai Science and Technology Committee etc.

Prof. Jian-Hua Yin

Dr Jian-Hua Yin is currently a professor in the Department of Civil and Structural Engineering of The Hong Kong Polytechnic University. Professor Yin received a BEng degree in 1983 in Chinese Mainland, an MSc degree from Institute of Rock and Soil Mechanics of the Chinese Academy of Sciences in 1984, and a PhD from The University of Manitoba, Canada in 1990. Dr Yin has a mix of industrial and academic experiences. He joined Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University in 1995 as an Assistant Professor. He was promoted to an Associate Professor position in 1999, to a Professor position in 2002, and recently to the position of Chair Professor of Soil Mechanics in 2014. Professor Yin has a good track record in research and has played a leading role in development of advanced soil testing equipment, innovative fiber optical sensors, establishing a large-scale multi-purpose physical modeling facility for studying geo-hazards, organization of regional and international conferences. His research interests include (i) testing study of properties and behaviour of soils, (ii) elastic visco-plastic modeling, (iii) soft soil improvement, (iv) soil nails and slope analysis, (v) development and applications fiber optical sensors, (vi) soil-structure interface, and (vii) development of advanced/special lab test apparatus. Currently, Professor Yin serves as a Vice-President of International Association for Computer Methods and Advances in Geomechanics (IACMAG), Co-Editor of International Journal of Geomechanics, Co-Editor of Geomechanics and Geoengineering, and Associate Editor of Canadian Geotechnical Journal. He has received the honours of the prestigious "JOHN BOOKER Medal" in 2008, "Chandra S. Desai Excellence Award" in 2011 from IACMAG, and delivering the high-status 2011 "Huang Wenxi Lecture" in Chinese Mainland.

SPECIAL FEATURE STORY ON
"Soil Mechanics at Emmanuel College –Elegant, Rigorous and Relevant"
By John Burland

Professor John Burland

Born in the UK, Professor Burland was educated in South Africa and studied Civil Engineering at the University of the Witwatersrand. He returned to England in 1961 and worked with Ove Arup and Partners for a few years.

After studying for his PhD at Cambridge University, John Burland joined the UK Building Research Station in 1966, became Head of the Geotechnics Division in 1972 and Assistant Director in 1979. In 1980 he was appointed to the Chair of Soil Mechanics at the Imperial College London. He is now Emeritus Professor and Senior Research Investigator at Imperial College.

In addition to being very active in teaching (which he loves) and research, John Burland has been responsible for advising on the design of many large ground engineering projects world-wide including the underground car park at the Palace of Westminster and the foundations of the Queen Elizabeth II Conference Centre in London. He specialises in problems relating to the interaction between the ground and masonry buildings. He was London Underground's expert witness for the Parliamentary Select Committees on the Jubilee Line Extension underground railway and has advised on many geotechnical aspects of that project, including ensuring the stability of the Big Ben Clock Tower. He was a member of the international board of consultants advising on the stabilisation of the Metropolitan Cathedral of Mexico City and was a member of the Italian Prime Minister's Commission for stabilising the Leaning Tower of Pisa.

He has received many awards and medals including the Gold Medal for engineering excellence of the World Federation of Engineering Organisations and the Gold Medals of the UK Institution of Structural Engineers and of the UK Institution of Civil Engineers. In 1994 he was awarded the Kevin Nash Gold Medal of the International Society of Soil Mechanics and Geotechnical Engineering 'In recognition of outstanding services to ISSMGE, to International Goodwill and to International Geotechnical Practice and Education'. In 1996 he was awarded the Harry Seed Memorial Medal of the American Society of Civil Engineers 'for distinguished contributions as an engineer, scientist and teacher in soil mechanics'. He is a Fellow of both the UK Royal Academy of Engineering and of the Royal Society of London and was appointed Commander of the Most Excellent Order of the British Empire in 2005.

SPECIAL FEATURE STORY ON
"Ground Improvement Methods for Port Infrastructure Expansion"
By Indraratna B., Heitor, A and Rujikiatkamjorn, C.

Prof. Buddhima Indraratna, PhD

Buddhima Indraratna is a Civil Engineering graduate from Imperial College, London, and obtained his PhD from the University of Alberta in 1987. He has worked in industry in several countries before becoming an academic at AIT during the period 1988-1991, in which he was an Assistant Professor and then Associate Professor. He was involved in a number of major infrastructure projects in Thailand and Southeast Asia during that time. Subsequently, his contributions to the analysis of 2nd Bangkok International Airport (Suvarnabhumi) are well-known and published in major international journals.

Prof Indraratna's significant contributions to geotechnical and railway engineering have been acknowledged through numerous national and international awards, including the 2016 Inaugural Ralph Proctor Lecture by the International Society of Soil Mechanics and Geotechnical Engineering, the most prestigious award in Transport Geotechnics. In 2009, he delivered the prestigious E.H. Davis Memorial Lecture of Australian Geomechanics Society for distinguished contributions to theory and practice of geomechanics. In 2014, he received the C.S. Desai Medal from the International Association for Computer Methods and Advances in Geomechanics (IACMAG) for outstanding contribution to geotechnical research and education. For his pioneering contributions to Australian railway innovations, he was honoured with the prestigious Business and Higher Education award by the Australian Government in 2009, Engineers Australia Transport Medal in 2011 and 2015 Australasian Railway Society's Outstanding Individual Award. Over the past two decades, he has also received numerous best paper awards, for example Thomas Telford Premium Award by the Institution of Civil Engineers, UK amd Robert Quigley Award by the Canadian Geotechnical Society. He was instrumental in changing the Australian standards the use of vertical drains in soft foundations soils and for revising the standards for railway ballast.

Prof Indraratna currently leads numerous projects funded by the Australian Research Council with over $15 million dollars over the past decade, and he has been a geotechnical consultant worldwide, and a United Nations consultant. He was also an Advisor to the Ministry of Science and Technology (Thailand) for new railway network planning and design, and an Advisor to the Government of Sri Lanka on Post-tsunami rehabilitation of railways. He has more than 550 publications including over 230 reputed journal papers, 9 Books and over 45 invited keynote papers. He has supervised over 50 PhD graduates and 30 Postdoctoral Fellows.

Professor Indraratna is a Fellow of the most prestigious Australian Academy of Technological Sciences and Engineering (FTSE), as well as a Fellow of several professional organisations including the Institution of Engineers, Australia (FIEAust), American Society of Civil Engineers (FASCE), Australasian Institute of Mining & Metallurgy (FAusIMM) and the Geological Society of UK (FGS).

GEOTECHNICAL ENGINEERING

PREFACE

This September 2015 issue of the journal contains fifteen interesting research papers and the details are described below. The time-dependency of the soft clay behaviour is studied in two papers by Wu *et al* and Ye *et al* as overview and interpretation of rate dependency and stress relaxation in soft clays respectively. In these papers, the strain rate dependent behaviour and under 1D and 3D stress conditions under complex loading conditions is studied through triaxial compression and extension tests under different OCR by Wu *et al* and the pore pressure development during stress relaxation by Ye *et al*. The latter paper also used stress relaxation curves in double logarithmic plane resulting in the development of a stress relaxation coefficient useful in analytical solutions for the 1D stress relaxation. A third paper by Bian *et al* proposes a new stress strain model based on CSSM for re-constituted clays which considers the effects of initial water contents. The model describes the undrained shear behaviour. With the decrease of initial water contents, the reconstituted clays experience enhanced strength, stiffness and dilation, which are not involved in the Modified Cam Clay model. These features can be captured by introducing a new hardening parameter ('quasi-structure' strength) into the conventional critical state model. The 'quasi-structure' strength increases with the decrease of initial water contents. The available test data on the undrained shear behaviour of reconstituted clays at different initial water contents are used to verify the proposed model, and the comparisons between computed and measured results show that the proposed model is able to predict the overall pattern of stress-strain curves, pore pressure variations and effective stress paths reasonably well, especially the ultimate undrained strength and pore pressure response at large strain.

The fourth paper is on the engineering behaviour of Shanghai soft clay by Lu *et al* by statistical analyses of the test data. The goodness-of-fits of normal distribution, log-normal distribution, exponential distribution and uniform distribution are assessed for each parameter using the Kolmogorov-Smirnov (K-S) method. The results show that the normal distribution is suitable for initial water content, specific gravity, plasticity index, liquidity index and unit weight, the log-normal distribution is suitable for initial void ratio and plastic limit, the exponential distribution is suitable only for liquid limit, and the uniform distribution is not recommended.

Wang *et al* in the fifth paper deal with the dynamic behaviour of frozen soils. The dynamic response of frozen soils is one of the significant factors that should be taken into account when designing and constructing infrastructures in cold regions. This paper firstly reviews the state-of-the-art of dynamic testing techniques including dynamic uniaxial/triaxial test, resonant column test, wave velocity test and the SHPB test. Then the correlations of dynamic indexes for frozen soils with test conditions are analyzed i.e., dynamic modulus, dynamic strength, damping ratio as well as dynamic Poisson's ratio. The typical stress-strain relationships for frozen soils under dynamic loading are summarized such as empirical models, creep modelling and strength criterion for frozen soils. Finally promising prospects of the study in this paper is suggested.

Ye *et al* (in sixth paper) is on the mineral constituents of one dimensional compression behaviour of clayey soils. Only few data are available concerning the effect of the four main clay minerals, kaolinite (K), illite (I), montmorillonite (M) and chlorite (C), on the mechanical properties of clayey soils. This paper discusses the effect of different mineral contents on the compression and swelling indexes of clay mixtures in order to provide correlations between the mineralogical content of a clayey soil and its compressive properties. Four pure clay powders were used to prepare 34 clay mixtures (different proportions of K+I, K+I+M, K+I+C). Conventional oedometer tests were conducted on all the prepared samples. Based on the test results, the evolution of the compressive properties with the proportions of pure clays was estimated and relevant correlations are suggested. All the results demonstrate that the compression and swelling indexes are reasonably well correlated to the proportion of clay minerals. The content in montmorillonite influences significantly the compressive properties of clayey soils, and the contents of illite and chlorite are less influential when added to kaolinite based clayey soils. Moreover, 15 samples with different proportions of K+I+M+C were prepared and tested, and the proposed correlations were validated in light of the results obtained on these materials.

The seventh paper by Fan *et al*, investigates the addition of fine grained Zeolite on the compressibility and hydraulic conductivity of clayey soil treated with calcium bentonite and used as backfills for vertical cut off walls. Vertical cutoff walls, using backfill consisting of on-site sandy soil and Na-bentonite are widely used as engineering barriers for the purpose of achieving relatively low hydraulic conductivity and high contaminant sorption capacity. At some sites, locally available clayey soil, Ca-bentonite and natural zeolite may be considered as an alternate backfill. However, studies on the compressibility and hydraulic conductivity of zeolite-amended clayey soil/Ca-bentonite backfills for vertical cutoff walls are very limited. A series of one-dimensional consolidation tests is performed to evaluate the compressibility and hydraulic conductivity of fine-grained zeolite-amended clayey soil/Ca-bentonite backfills. Kaolin is used as the control clayey soil, and it is amended with various amounts of Ca-bentonite (5, 10, and 15%) and zeolite (2 - 40%) to prepare zeolite-amended kaolin-bentonite backfills. The results indicate that the addition of fine-grained zeolite has insignificant influence on the compressibility and hydraulic conductivity of clayey soil/Ca-bentonite and sandy soil/Na-bentonite backfills. The hydraulic conductivity of the zeolite-amended clayey soil/Ca-bentonite backfills is generally lower than the typical regulatory limit of 10-9 m/s. Two empirical methods, based on the Nagaraj's generalized void ratio (e/eL) and Sivapullaiah *et al*.'s method are assessed to predict the hydraulic conductivity of the backfills. The proposed method based on the Sivapullaiah *et al*.'s method is shown to estimate the hydraulic conductivity for the fine-grained zeolite-amended clayey soil/Ca-bentonite backfills with reasonable accuracy.

The eighth paper by Cheng and Saiyouri is titled effect of long term aggressive environments on the porosity and permeability of granular materials reinforced by nano-silica and sodium silicate. Colloidal nanosilica is a kind of new chemical grout materials for filling small pores of fine-grained soil. Compared to traditional sodium silicate material, the advantages and disadvantages of colloidal nanosilica are studied under laboratory conditions for pure gels and sand-gel mixtures for long-term volume stability. Samples of Fontainebleau sand injected by nanosilica and sodium silicate were conserved in dry air, water, salt solution and acid solution for 8 different time periods. The results show that pure gel of nanosilica is much more stable than pure gel of silicate sodium in all environments studied; from results of porosity, nanosilica does not has manifest advantages compared with sodium silicate; from results of permeability, nanosilica sand has more stable capacity of water-blocking in all environments.

The ninth paper by Deka *et al* is on strength of lime treated flyash using bentonite. The class "F" type Fly ash is non-cohesive and is normally strengthened or reinforced when used in structural fills. This paper deals with strength increase in unconfined compressive tests by pozzolanic reactions with lime and also bentonite.

The tenth paper is by Wang *et al* on soil deformation induced by underground tunnel construction. Development and utilization of underground railways can effectively ease the problem of urban traffic congestion. However, surrounding soil disturbance during tunnel excavation is likely to cause serious accidents. Thus, analyzing soil deformation during tunnel excavation is important. Through numerical simulation, this paper analyzes the influence of the step distance of a single-bore tunnel on the disturbance of the surrounding soil. Based on research on a single-bore tunnel, this paper further examines the effects of various spacing, locations, and excavation methods on the deformation of surrounding soils during parallel tunnel excavation. The results show that longer excavation steps lead to more intense disturbance to the surrounding soils. The most intense disturbance occurs at the ends of the tunnel. During new tunnel excavation, the tunnel crossing angle has stronger influence than the tunnel spacing on the original tunnel. Among the four excavation methods, single-bore advanced through is the most secure, whereas simultaneous excavation from opposite directions can cause the most intense disturbance to the surrounding soils. In practical operations, corresponding excavation methods can be employed according to specific conditions. Moreover, in-situ monitoring at key positions should be enhanced to avoid accidents.

The eleventh paper by Zhou *et al* is on full scale field tests on soil arching triggered during the construction of shallowly buried HDPE pipes. Soil arching significantly affects earth pressures around and above high-density polyethylene (HDPE) pipes in the construction phase. However, few studies have systematically addressed the change of soil arching with respect to soil cover thickness during the installation of HDPE pipes. This paper presents full-scale field investigations on the soil arching above and around three HDPE pipes buried shallowly in trenches. The results demonstrate that the soil arching developed in the backfill above the pipes is getting significant with increasing soil cover thickness. At a given soil cover thickness, more notable soil arching is found at a position closer to the pipe crown. The measured earth pressures acting on the pipe crown are compared with those estimated by the Marston load theory. It is found that the crown earth pressures estimated by the Marston's trench equation and embankment equation are 8% to 32% and 2% to 14% respectively higher than those obtained from the field tests. The results suggest that a threshold trench width is likely to exist when the Marston load theory is used for calculating the earth pressures on the top of HDPE pipes buried in the trench.

The twelfth paper is on a pollutant migration model considering solute decay in layered soil by Yu and Cai. Organic pollutant solute undergoes significant decay during the migration process in clay liner systems and foundation clay. Liner and foundation soil have layered properties. A one-dimensional computational model is established to calculate pollutant migration by considering the decay in layered soil medium. The separation of variable method is used to obtain the analytical solution. To verify the capability of the developed method, a typical example is illustrated by applying this model. The calculated results are compared with the results obtained from the GAEA Pollute v7. Consistent results demonstrate the reliability and validity of the proposed migration model, which can be a promising tool for landfill liner design when considering the organic pollutant decay.

The thirteenth paper is on effect of cyclic strain history on shear modulus of dry sand using resonant column tests by Jyant Kumar and Achu Catherine Cherian. A number of resonant column tests were performed on dry sand specimens to examine the effect of cyclic shear strain history, by including both increasing and decreasing strain paths, on the shear modulus (G) for different relative densities (Dr) and confining pressures (σ_3). The specimen was subjected to a series of cycles of increasing and decreasing shear strain paths approximately in a range of 0.001-0.1%. For a particular cycle, with a given strain amplitude, the shear modulus during the increasing strain path becomes always greater than that during the decreasing strain path. For a given cycle, irrespective of relative density of sand, the difference between the values of G associated with the increasing and decreasing strain paths becomes always the maximum corresponding to a certain shear strain level. The maximum reduction in the shear modulus, due to the cyclic variation of the shear strain, was noted to be around one fourth of the maximum shear modulus (G_0). This reduction in the shear modulus on account of the cyclic variation of shear strain increases generally with decreases in the values of both relative density and confining pressure. The study will be useful to examine the response of sand media subjected to earthquake excitation.

Bhattacharya and Kumar are the authors of the fourteenth paper on vertical uplift capacity of circular anchor plates. Experimental and numerical investigations have been carried out to determine the vertical uplift resistance of circular anchor plates embedded in cohesionless soil media. Experimental studies are performed on model circular anchor plates placed at different depths in loose to medium dry sand deposit for two different relative densities, namely, 25% and 65%, respectively. The numerical work has been done by using an axisymmetric lower bound limit analysis in conjunction with finite elements and linear programming to compute the uplift resistance offered by circular anchor plates embedded horizontally in sand. In the case of numerical studies, the internal frictional angle of sand was varied from 20° to 45°. Both experimental and numerical studies clearly reveal that the uplift resistance of the circular plate increases considerably with increases in embedment ratio (H/D), and soil frictional angle (ϕ). The deformation of the anchor plate, corresponding to the failure load, increases with an increase in the values of H/D and relative density of sand. The values of the failure loads obtained from the computational analysis match well with the present experimental results as well with the available data from literature.

In this fifteenth paper by Benson Hsiung and Sy-Dan Dao, a simple method for predicting movements, especially the ground surface settlements, caused by deep excavations in sands is presented. The case history of deep excavation in thick layers of sand is adopted from Kaohsiung, Taiwan as the basis for numerical analyses. In order to improve the inconsistence in prediction of ground surface settlements induced by the deep excavation, the analysis using the simple constitutive model but with additional two factors, α and β is applied. The factor α defines the width of primary strain zone behind the retaining wall, and β indicates the difference of soil stiffness in two zones of the primary strain zone and small strain zone. It is concluded that changing α seems not to induce significant change, and values of β from 3 to 5 shall be taken once such approach intends to be adopted for predicting ground surface settlements caused by deep excavations in sands.

The editors are grateful to the authors and reviewers and are very pleased with the significant contributions made by them in making this Issue feasible to our SE Asian Geotechnical Community and others.

Zhen-Yu Yin
Jian-Hua Yin

ACKNOWLEDGEMENT

This September 2015 Issue is edited by Profs. Zhen-Yu Yin and Jian-Hua Yin. They are to be congratulated for acquiring fifteen excellent papers, which covers a wide range of topics which will be of great value to researchers and practitioners. Details of the contents are in the Preface as compiled by the editors. They cover strain rate effects and stress relaxation with a new Stress strain Model as based on CSSM; the engineering behaviour of Shanghai soft clay is statistically analyzed; the dynamic behavior of frozen soils is studied using dynamic uniaxial/triaxial test, resonant column test, wave velocity test and the SHPB test. The addition of fine grained Zeolite on the compressibility and hydraulic conductivity of clayey soil treated with calcium bentonite and used as backfills for vertical cut off walls is also presented. Additionally, effect of long term aggressive environments on the porosity and permeability of granular materials reinforced by nano-silica and sodium silicate is also presented. The strength of lime treated flyash using bentonite is also studied in detail; the class "F" type Fly ash is non-cohesive and is normally strengthened or reinforced when used in structural fills. Soil deformation induced by underground tunnel construction is of importance. Among the four excavation methods, single-bore advanced through is the most secure, whereas simultaneous excavation from opposite directions can cause the most intense disturbance to the surrounding soils. In practical operations, corresponding excavation methods can be employed according to specific conditions. Moreover, in-situ monitoring at key positions should be enhanced to avoid accidents.

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No doubt, this Issue will be most useful to our Profession and all those who are engaged in Pile Foundation Research and Practice. Sincere thanks to all who have contributed to the success of this issue of our journal under the able leadership of Profs. Zhen-Yu Yin and Jian-Hua Yin

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GEOTECHNICAL ENGINEERING

SEPTEMBER 2015: SPECIAL ISSUE ON SOIL BEHAVIOUR AND MODELLING

Editors: Prof. Zhen-Yu Yin and Prof. Jian-Hua Yin

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