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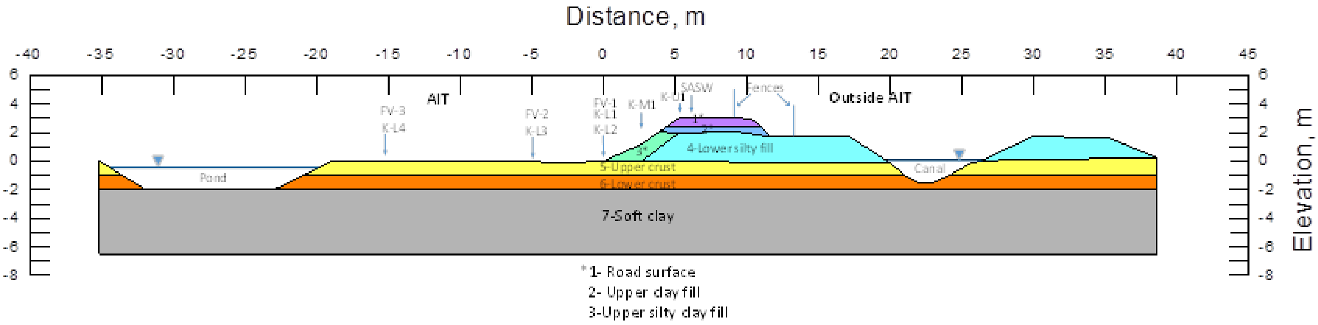

Photo 1: Cross-section of the instrumented AIT dyke (After Jotisankasa, Pramusandi, Nishimura and Chaiprakaikeow, 2019)

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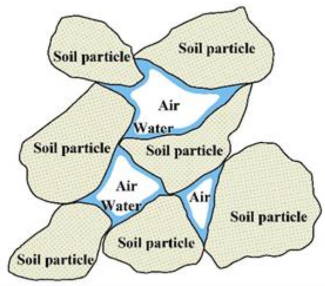
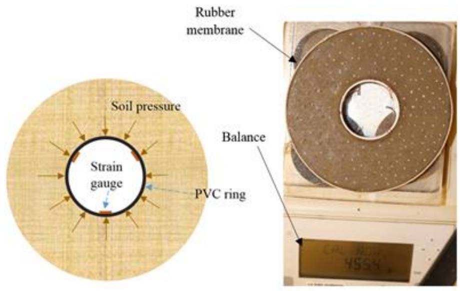


Photo 3: Schematic microscopic state of unsaturated soil on particle scale (After Kitamura and Sako, 2019)



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PREFACE

March 2019 Issue

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

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

The first two papers are on the soil-water retention curves. Soil-water retention curve is considered a basic property of unsaturated soils and the curve has been used to estimate the permeability function and shear strength of unsaturated soils. In the first paper on Water Retention Characteristics of Swelling Clays by Kannan K.R. Iyer and D.N. Singh, the effect of the initial state of soil (viz., slurried, intact or compacted state) on the soil-water retention characteristics (SWRC) and the unsaturated soil behaviour for swelling clays was investigated. Drying and wetting soil-water retention curves were obtained for intact and reconstituted specimens of swelling clays using a dewpoint potentiameter (WP4C) and environmental chamber. The study found that initial water content has a greater effect on the drying SWRC than the wetting SWRC. In addition, the drying SWRCs for intact and reconstituted specimens converge beyond certain stage of drying. They suggested that reconstituted specimens can be used for studying behaviour of intact clays in relatively dry state.

The second paper on Water Retention and Unsaturated Hydraulic Behaviours of a Biochar-modified Silt by Abraham C.F. Chiu, B. Qiao and Y. Xiao investigated the effects of biochar content and void ratio on the water retention and unsaturated hydraulic behaviors of a biochar-modified silt for application as a soil cover of municipal solid waste landfill to mitigate methane emission. A rice straw derived biochar was used. The characteristics of biochar are high internal porosities and negative surface charge. Adding biochar to the silt creates more flocculated microstructures and the pore size distributions measured by the mercury intrusion porosimetry indicate that the biochar-modified silt contains more micro-porosities than the untreated silt. From modified evaporation test, increasing biochar content increases the water retention capacity of the biochar-modified silt. However, the biochar-modified silt shows a lower saturated permeability and also a lower rate of change in permeability with respect to suction. Although the biochar-modified silt is less permeable than the untreated silt in the low suction range, it becomes more permeable after drying in the high suction range. The findings may have implications on its application as a soil cover of municipal solid waste landfill to mitigate methane emission.

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

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

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

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

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

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

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

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

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

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

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

ACKNOWLEDGEMENT

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

Dr. Teik Aun Ooi
Prof. San Shyan Lin
Prof. Kwet Yew Yong
Dr. Noppadol Phienwej
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GEOTECHNICAL ENGINEERING

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

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

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

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