

# GEOTECHNICAL

# ENGINEERING

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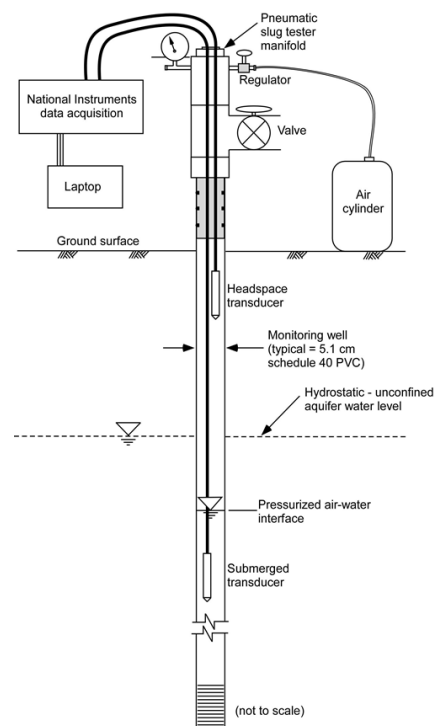
**Tom Lunne & Don de Groot**



CPT Testing in Peat (after Long & Boylan, 2012)



Dilatometer Earth Pressure Cell  
(after Lutenegeger, 2012)



Hydraulic Conductivity Test  
(After DeGroot et al, 2012; Dunaj et al. 2006)

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# GEOTECHNICAL ENGINEERING

## PREFACE

This special issue the journal is focused on in-situ testing of soils and covers recent developments in equipment and data interpretation, results from field programs conducted at research test sites, and case histories.

In-situ testing and soil sampling with subsequent laboratory testing are the key components of geotechnical site investigation practice. Because of the wide range of soils and soil behavioural response that can be encountered during a site investigation there is correspondingly a large variety of in-situ tools that have been developed and used in practice. Collectively, the eight papers in this special issue touch on aspects of many of the common devices including: standard penetration test, piezocone, seismic piezcone, field vane, seismic dilatometer, pressure-meter, full-flow penetrometers, and earth pressure cells. Topics include determination of key soil properties for design such as undrained shear strength, shear wave velocity, pre-consolidation stress, effective stress friction angle, lateral earth pressure, cyclic resistance, and hydraulic conductivity. Results presented in the papers cover the full spectrum of soils including low and high plasticity clays, sensitive clays, plastic and non-plastic silts, sands, gravels and peat. The data presented for the case histories and also that collected at the research test sites provide a valuable frame of reference for future investigations in similar soils.

The Guest Editors thank the authors for their contributions and all the reviewers for the time and dedication in reviewing the manuscripts. We also thank Prof A. S. Balasubramaniam and Dr T.A. Ooi for the opportunity to serve as Guest Editors and especially for their constant encouragement and assistance during the preparation of this issue and guiding its publication to fruition.

## **GEOTECHNICAL ENGINEERING**

### **ACKNOWLEDGEMENT**

The December 2012 Issue of the journal have Tom Lunne from Norwegian Geotechnical Institute (NGI) and Prof. Don J De Groot from University of Massachusetts, Amherst, USA as Guest Editors. This Special Issue is devoted to In-situ testing of soils. NGI is in the forefront of in-situ testing and instrumentation from early 1950 with Arild Andressen, Gunar Aas and Dr. Elmo Dibiagio, with Tom Lunne and others.

There are eight excellent papers authored by: A. S. Bradshaw, A. C. Morales-Velez, and C.D.P. Baxter; A. Emdal, M. Long, A. Bihs, A. Gylland and N. Boylan; Alan J. Lutenege; T. Ku and P.W. Mayne; M. Long and N. Boylan; K.H. Goh, K. Jeyatharan and D. Wen; D.J. De Groot, D.W. Ostendorf, and A.I. Judge; and F. A. B. Danziger and T. Lunne. The topics covered include: Evaluation of Existing CPT Correlations in Silt; Characterisation of Quick Clay at Dragvoll, Trondheim, Norway; Field Response of Push-In Earth Pressure Cells for Instrumentation and Site Characterization of Soils; Frequent-Interval SDMT and Continuous SCPTu for Detailed Shear Wave Velocity Profiling in Soils; In Situ Testing of Peat – a Review and Update on Recent Developments; Understanding the stiffness of soils in Singapore from pressuremeter testing; In situ measurement of hydraulic conductivity of saturated soils; and Rate effect on cone penetration test in sand.

Tom Lunne and Prof. Don J De Groot must be congratulated in having such excellent articles from well known authors in in-situ testing of soils. Sincere thanks are due to all the contributing authors.

All the four Issues in March, June, September and December for the year 2012 are released well in time and the credits must go to the Guest Editors, reviewers and the in-house editorial teams. We now look ahead for the Issues of 2013 for which the Guest Editors are in advanced stage with the preparation. Special Issues on important topics are covered in the 2011 and 2012 Issues and the articles would be of great value to practitioners as well as researchers.

**K.Y. Yong  
D.T. Bergado  
T.A.Ooi  
A.S.Balasubramaniam**



## **GEOTECHNICAL ENGINEERING**

### **DECEMBER 2012 SPECIAL ISSUE ON INSITU TESTING OF SOILS**

Guest Editors: TOM LUNNE and Prof DON J. DEGROOT

#### **TOM LUNNE**

Tom Lunne was educated at Heriot-Watt University in UK and at University of California Berkeley. He is currently Technical Advisor and Manager of Offshore Soil Investigations at the Norwegian Geotechnical Institute (NGI), Oslo, Norway. He has a diverse geotechnical engineering background resulting from both his consulting and research and development activities. Major activities have included: laboratory testing, in situ testing, sampling and evaluation of sample disturbance, field observations, evaluation of soil parameters; and planning, specifying and managing large offshore soil investigations. Tom has worked on numerous major projects worldwide. Tom has given invited lectures and presentations at conferences and conducted short courses worldwide. He is an active member of several technical committees including: Core Member of Committee TC-16 on In Situ Testing, International Society of Soil Mechanics and Geotechnical Engineering (1982 - present); Scandinavian Committee on Field Investigations, 1993 - 2004; Chairman of the Norwegian Committee on Field Investigations, 1993 - 2004; Member of the Committee of European Standard of CPT, (2001 - present). He is the author or co-author of more than 100 papers, publications and technical notes to professional journals and conferences and is the lead author of the book Cone Penetration Testing in Engineering Practice.

#### **Prof DON J. DEGROOT**

Prof Don J. DeGroot is a professor in the Department of Civil and Environmental Engineering at the University of Massachusetts Amherst, Amherst, MA, USA and a registered Professional Engineer in the USA. He received his D.Sc. in geotechnical engineering at the Massachusetts Institute of Technology in 1989. His teaching, research, and consultancy experience is primarily in the area of soil behaviour and environmental geotechnics with an emphasis on site characterization practice. He has been a Principal Investigator on numerous sponsored research projects including the recently completed \$2.4 million US National Science Foundation project on "Developing International Protocols for Offshore Sediments and their Role in Geohazards: Characterization, Assessment, and Mitigation." He has published refereed research findings in many of the major geotechnical engineering journals, ASCE Geotechnical Special Publications, ASTM Special Technical Publications and TRB publications. National and international conferences activities include several Keynote and State-of-the-Art papers, presentations, and short courses. He has served on the editorial boards of the Journal of Geotechnical and Geoenvironmental Engineering and the Geotechnical Testing Journal and served as Chair of the ASCE Geo-Institute Soil Properties and Modeling Committee. Teaching and research awards include the James L. Tighe Civil Engineering Distinguished Teaching Award, United Technologies Corporation Outstanding Laboratory Teaching Award, Research Council of Norway Guest Researcher Fellowship, University of Western Australia Gledden Visiting Senior Fellowship, and the CEE Research Excellence Award.

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## Special Issue on In-situ Testing of Soils

*Guest Editors: Tom Lunne and Don J. DeGroot*

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### Cover Photographs:

- CPT Testing in Peat (after Long & Boylan, 2012)
- Dilatometer Earth Pressure Cell (after Lutenegeger, 2012)
- Hydraulic Conductivity Test (After DeGroot et al, 2012; Dunaj et al. 2006)

## PAPER CONTRIBUTIONS

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- American Petroleum Institute (API) (1993). Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms – Working Stress Design, API Recommended Practice 2AWSD (RP 2A-WSD), 20th edition, 1993, p191
- Earth, J.B., and Geo, W.P. (2011) "Asian Geotechnical amongst Authors of Conference Publications", Proceedings of Int. Conference on Asian Geotechnical, publisher, city, pp 133-137.
- 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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