INTRODUCTION TO THE "CGSE SPECIAL ISSUE" OF *AUSTRALIAN GEOMECHANICS*

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The Newcastle Chapter of the Australian Geomechanics Society is pleased to dedicate its themed issue of *Australian Geomechanics* to the activities of the Australian Research Council Centre of Excellence for Geotechnical Science and Engineering (CGSE), which combines three of Australia's leading geotechnical research groups: the Centre for Geotechnical and Materials Modelling at The University of Newcastle, the Centre for Offshore Foundation Systems at The University of Western Australia, and the Centre for Geotechnics and Railway Engineering at the University of Wollongong. With a forecast investment of over 250 billion dollars in Australia's energy and transport infrastructure over the next five years, there is an unprecedented need to design and build this infrastructure as cheaply and safely as possible. In light of the size of investment involved, even small percentage savings resulting from scientific research will lead to huge returns in absolute dollar terms. Through advanced laboratory testing, physical modelling, full-scale field testing and cutting-edge computational simulations, the CGSE is providing engineers with new science-based tools for designing safer and cheaper energy and transport infrastructure such as roads, railways, port facilities, tunnels, dams, pipelines, mining operations and offshore oil and gas facilities. The CGSE has four geotechnical science themes, each of which is linked to advanced computational modelling, state-of-the-art physical modelling and laboratory testing, and engineering applications: Geomaterial Science, Multiphysics Modelling, Moving Boundary Problems and Georisk.

The collection of articles in this issue highlights the complementary skills and facilities brought together from each of the nodes and the innovative research produced by the CGSE. The first of two articles that summarise recent developments in the testing equipment and physical modelling techniques available within the CGSE is the contribution by Cassidy *et al*. (2014), which describes the new National Geotechnical Centrifuge Facility, a recently established mobile *in situ* testing laboratory, and the new national facility for the cyclic testing of high-speed rail. The second paper by White *et al*. (2014) describes the recirculating flumes, or O-tubes, that allow for simulation of ocean-structure-seabed interactions in offshore applications and, in particular, the stability of pipelines on mobile seabeds.

A series of papers covers various aspects of the work being conducted in conjunction with soft soils, for which the CGSE has developed Australia's first National Soft Soil Field Testing Facility (NFTF) in Ballina, NSW. These articles include an overview of the site and the *in situ* testing programme (Kelly *et al*., 2014), a discussion of current and future work on sampling and laboratory testing on Ballina clay (Pineda *et al*., 2014), an investigation of spatial variability based on field tests completed at the NFTF (Li *et al*., 2014), and a study aimed at investigating the effects of strain rate and softening in vane shear testing (Ansari *et al*., 2014). A fifth article on soft soil focuses on developments in the understanding of vacuum preloading as a means of accelerating consolidation (Indraratna *et al*., 2014a).

Three articles describe past, present, and future research on onshore and offshore foundations. Gaudin *et al*. (2014) give a comprehensive review of the analytical, numerical, and physical modelling techniques developed within the CGSE to understand and predict the performance of offshore anchoring systems. Hambleton *et al*. (2014a) present findings within a new focus area on modelling the installation process for helical anchors and piles. Gourvenec and Feng (2014) describe the innovative design methodologies developed to economise offshore foundations through analysis of the capacity, foundation configuration, soil characteristics, and the mode of operation.

In the area of transportation geotechnics, two contributions focus on the performance of railway foundations. The study by Tennakoon *et al*. (2014) considers the influence of contamination of ballast on its drainage and shear strength characteristics, and Indraratna *et al*. (2014b) review laboratory and field testing on shock mats which can be used to reduce ballast degradation and improve stability of railroad tracks. A third study on transportation geotechnics (Heitor *et al*., 2014) examines cost-effective techniques for assessing the adequacy of compaction in projects with high fills covering large areas, where conventional quality control methods can be prohibitively expensive.

Two articles illustrate the challenges associated with problems involving ultra-large deformations. O'Loughlin *et al*. (2014) provide an overview of the centrifuge modelling, field testing, and numerical modelling being completed to understand and predict the behaviour of free falling projectiles such as torpedo anchors and penetrometers. Hambleton *et al*. (2014b) highlight current and future research initiatives within the CGSE on modelling the progressive displacement of soil in ploughing and cutting processes, which lie at the heart of earthmoving operations occurring at numerous scales in various environments.

Three papers showcase advances in the numerical and analytical tools developed within the CGSE. Kardani *et al*. (2014) demonstrate the improved computational performance that can be achieved in the numerical analysis of coupled consolidation problems through the use of high-order elements in adaptive finite element methods. Vinod *et al*. (2014) present a technique based on the discrete element method (DEM) for investigating the mechanical behaviour of sand containing methane hydrate. Huang *et al*. (2014) discuss the means by which Bayesian statistical methods can be used for improved prediction of performance geotechnical projects, considering two examples involving load testing of piles and settlement prediction from field monitoring data.

Each of the papers in this edition was anonymously peer-reviewed, and the Newcastle Chapter extends its sincerest gratitude to each of the reviewers.

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