Reprise of the 56th Rankine Lecture "Geotechnics and Energy"

by Ir. Dr Gue Chang Shin

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It was a great honour for the Geotechnical Engineering Technical Division (GETD) of IEM, to have Prof. Richard Jardine of Imperial College London, to reprise the 56th Rankine Lecture on "Geotechnics and Energy" at the Tan Sri Ir. Prof. Chin Fung Kee Auditorium, Wisma IEM on 26thJuly 2016. The Rankine Lecture is considered as the most prestigious invited geotechnical lecture in the world, which commemorates Prof. W.J.M. Rankine, best known for his theory for the earth pressure on retaining walls. IEM is privileged to be the first stop of the now accustomed Rankine Lecture tour after the actual 56thRankine Lecture in March 2016 at Imperial College London. The lecture was chaired by the technical division committee member, Ir. Dr. Gue Chang Shin.

The lecture was divided into three main parts, paired topics in each part:

- Part 1: Maintaining offshore oil & gas supplies – Driven piles & landslide hazards
- Part 2: Climate change – Geotechnical impact & adaptation
- Part 3: Improving renewable energy economics – Optimising jacket & monopile wind turbine foundations

In Part 1, Prof. Jardine brought the audience up-to-date on the current state-of-the-art in offshore driven piles, leading to the current research directions. In particular, pile ageing effects after full pore pressure equalisation. He showed that based on field tests of three identical piles tested at different ages after driving, remarkable improvement in pile capacity long after any pore pressure dissipation has been observed, as shown in Figure 1. Cyclic loading and the impact on performance of piles were also highlighted in the lecture. Prof. Jardine also stressed that the full stress regime around driven piles (not only the interface of piles) is important. The second topic in Part 1 is on offshore landslide hazards with salt intrusion beneath the marine sediments, where Prof. Jardine showed case on modelling and analyses of offshore landslides.

In Part 2, Prof. Jardine moved on to issues on climate change, on the modelling of geotechnical response and the practical adaptive design due to climate change. He focused on improving and increasing climate change resistance on coping with more frequent and intense rain and sea storms. He emphasised that it is essential in minimising environmental and economic costs to provide service and construction stability. A case study of long dike walls raised on peat foundations were presented, where field experiments to failure have been carried out together with the aid from laboratory and in-situ tests. The results show that consolidation times grow with load from days to months. In loading to failure, significant initial settlements followed by sudden vertical and lateral movements were observed. Prof. Jardine enlightened the audience that an adaptive stability design can be achieved through calibration of operational undrained shear strengths from in-situ and laboratory tests, and 'critical state' undrained shear strength – effective vertical stress (s_u-□'$_v$) relationships. This gives the operational undrained shear strength for a range of effective vertical stress as the adaptive stability design, as shown in Figure 2.

The final part of the lecture was on improving renewable energy economics, where Prof. Jardine highlighted on offshore multi-pile structures and the modernised monopile for wind-turbines. The key research areas include cyclic response, ageing effect and soil strength anisotropy. Similarly, field tests, laboratory tests and calibration with finite element analyses were integrated to achieve optimised offshore foundations.

Finally, Prof. Jardine concluded the lecture by stressing on the approach of integrating geology, experiments, analyses and full scale field observations are needed for the geotechnical progress towards resolving the energy conundrum. The lecture showcased extensive collaborative research and engagement with industry to arrive on fit for purpose practical tools that are, "As simple as possible, but no simpler". The course ended with rounds of applause from the audience and the appreciation momento was presented by the Advisor of GETD, Ir. Liew Shaw Shong to Prof. Richard Jardine (Figure 3).

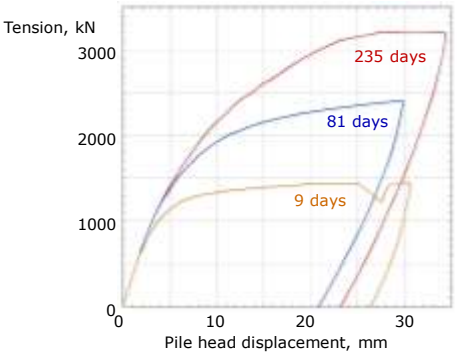

Figure 1: Pile capacity growth from pile ageing (shaft capacity from 1st time tests)

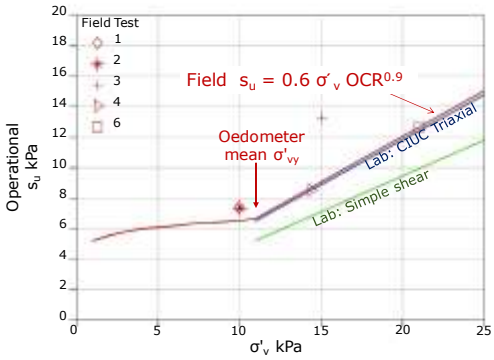

Figure 2: Calibrated undrained shear strength, s_u for adaptive stability design (an example)

Figure 3: Appreciation momento presented by Ir. Liew Shaw Shong to Prof. Richard Jardine