General Report for TC206
Interactive Design

Rapport général du TC206
Le dimensionnement géotechnique interactif

Ho A.
Ove Arup & Partners Hong Kong Ltd

ABSTRACT: This General Report is to summarise the all papers submitted for TC206 – Interactive Design. A total of 15 papers were received and 6 papers were recommended for oral presentation and the rest for recommended for panel presentation at the 18th ICSMGE Paris, 2-6 September 2013. The submitted papers gave a general picture of the interactive design works around the Globe ranging from experimental and theoretical works from SWOT analysis to geoenvironmental application and potential risk detection for Slope failure to case report on some successful practical works from excavation of diaphragm wall to fibre optic instrumentation in reusing deep foundations. The papers are of good quality and will generate opportunities for the academia and practitioners to discuss and question on various different techniques and approaches to implement interactive design to their works.

RÉSUMÉ : Ce rapport général présente une synthèse des communications correspondant au TC206 – Dimensionnement géotechnique interactif. Un total de 15 articles ont été reçus, 6 ont été recommandés pour une présentation orale et les autres seront présentés lors de la conférence correspondant à ce rapport général au 18ème CIMSG Paris, 2-6 septembre 2013. Les communications donnent une description générale des travaux en dimensionnement interactif de par le monde, depuis les travaux expérimentaux et théoriques jusqu'aux analyses SWOT, aux applications géoenvironnementales et à la détection des risques potentiels dans la réutilisation des fondations profondes. La bonne qualité des communications créera des opportunités pour les universitaires et les praticiens de discuter et échanger sur les différentes techniques et approches permettant de mettre en œuvre le dimensionnement interactif dans leurs réalisations.

KEYWORDS: Observational method, SWOT analysis, monitoring, risk of slope failure, small-strain, fibre-optic sensing technology.

1 INTRODUCTION

A total of 15 papers were received by the TC 206 – Interactive design and 6 papers were selected for oral presentation and the other for panel presentation at the 18th ICSMGE, Paris, 2-6 September 2013. The submitted papers gave a general picture of the interactive design works around the Globe ranging from experimental and theoretical works from SWOT analysis to geoenvironmental application and potential risk detection for Slope failure to case report on some successful practical works from excavation of diaphragm wall to fibre optic instrumentation in reusing deep foundations.

The following section will highlight some keys in the various papers submitted.

1.1 *Papers recommended for oral presentation*

Paper 1907 "Comparison of monitoring techniques for measuring deformations in an excavation" by DeVos, Van Alboon, Haelterman from Belgium. An online monitoring test set-up was realized in a railway-infrastructure project site in Anderlecht (Belgium). Both advanced and traditional monitoring equipment were installed to measure the deformation of a soil nailed jet grout wall, deformations behind the jet grout wall (on the railway tracks) and forces in the soil nails. The paper presents the results of the measurements in and behind the jet grout wall and on the comparison between the different techniques: FBGS; SAAF (in place inclinometer); Optical strands OSMOS; Traditional inclinometer; Draw Tower Grating; and BOTDR. It concluded that both new and traditional techniques can lead to the same result, when sufficient care is taken in the installation and interpretation. A significant advantage can be seen when continuous monitoring is applied, as the link with execution phases can be made.

The paper is clearly set out and well written and presents a real site monitoring case and compares predicted with actual deformation and bending moment results.

Paper 2397"SWOT analysis Observational Method applications" by Korf, de Jong and Bles from Holland. A well set out account of Strengths, Weaknesses, Opportunities and Strengths of Observational Method and draws on a wide range of published work. This research is performed as part of "Geoimpuls" in the Netherlands; a joint industry programme, with the ambitious goal to half the occurrence of geotechnical failure in Dutch civil engineering projects by 2015. The Conclusion are given in the form of "Go", "No Go" listed in terms of importance and "To be Overcome" items.

Paper 2029 "Experimental analyses on detection of potential risk of slope failure by monitoring of shear strain in the shallow section" by Tamate & Hori from Japan. The paper consider monitoring locations at shallow depth of slope and introduces a mean to monitor the failure of shallow portion of slope which is particularly important during temporary cut. It may attract discussions in how to bring this into practice so as to enhance safety control measures to safeguard the workers during actual construction stage. It would be good to have a paragraph summarizing their findings from the experiment and / or any further study that may be worthwhile, e.g. any suggested alert, alarm and action shear strain to quantify the potential risk level.

Paper 3059 "The role of fibre optic instrumentation in the re-use of deep foundations" by Bell, Soga, Ouyang, Yan and Wang from UK & China. This paper provided details of a recent project in London to further develop the understanding of foundation reuse by installing fibre optic sensors in both existing piles and a borehole to observe the impact of the demolition process on the changes in piles behavior and ground response. It explained how optical fibre instrumentation was used to monitor pile and ground response under demolition and presented the data captured by the fibre optic instrumentation during the demolition process. It also showed how the use of such instrumentation was fundamental to the successful reuse of the existing piles on this project. It would be good to include the limitations of fibre optic instrumentation; such as can it quantify the vertical extent of section changes or the lateral position of defects; the presence of vertical cracks. And percentage of

existing pile to be instrumented to assess the integrity of existing piles for reuse can also be discussed.

Paper 2971" New Sensing Technology and New Applications in Geotechnical Engineering" by Wang, Ooi & Gao from Hong Kong. The paper described that soils are inherently a particulate medium, and relevant physical principles behind the macro-scale engineering properties originate from particle interactions. However, it is difficult in general to conduct measurements which can monitor soil particle movement and even characterize micromechanics behind different soil behaviour. The paper presented two examples of advancement of sensing technologies. The first is on using the tactile pressure sensor (film-like sensor) to monitor the evolution of contact normal forces among particles in aged sand. The measurement reveals that the contact forces are continuously redistributed during aging. This ultimately strengthens the soil structure and therefore increases the associated small-strain shear modulus. The second is on using the miniature 3D Micro-Electro-Mechanical-Systems (MEMS) accelerometer to characterize the soil movement in a laboratory flow landslide. The MEMS sensors demonstrate promising results in describing the rich features of local responses of soil movement in the shear zone, e.g. liquefaction, deceleration, contraction and dilation. Some comments on the paper: Are the sensors insensitive to any other property likely to be encountered in its application and to what extent the sensors influence the measured property? Are the sensors designed to be linear or linear to some simple mathematical function of the measurement, typically logarithmic? What is the dynamic error of MEMS accelerometer? A very relevant paper on application of the small-strain theory on flow slides.

Paper 1965 "Monitoring earthwork foundations by fibre optic sensors" by Artières from France. The paper presented that strain in earthworks is now easier to measure by using fibre optic sensing technologies combined with geotextile properties, such as very good soil friction interface enhancing the transfer of soil displacement to the sensors. More accurate measurements can be obtained due to their smaller and less intrusive size than those of the usual electro-mechanical strain gages. They have high sensing sensitiveness below 0.01% on strain measurement, but also temperature measurement with 0.1°C accuracy, that is combined with a high spatial resolution in the range of 1 m or less and a good durability of the sensors into soil. And they can be used to monitor either local earthworks such as walls and slopes or long infrastructures of several tenths of kilometers such as roads, railways and dikes, all with the same accuracy. Several tenths of earthworks are now monitored globally with this solution for more than 8 years demonstrating its durability. The detection of cavities in the foundation of a large polluted water storage basin was also described. Some comments on the paper: Are the sensors insensitive to any other property likely to be encountered in its application and to what extent the sensors influence the measured property? And are the sensors designed to be linear or linear to some simple mathematical function of the measurement, typically logarithmic? The paper was selected for oral presentation on its relevancy in the application of sensor technology in practical works.

1.2 *Papers recommended for panel presentation*

Paper 2253 "Development of Method for Evaluating and Visualizing 3-dimensional Deformation of Earth Retaining Wall for Excavation" by Matsumaru and Kojima from Japan. The paper described a System to evaluate and visualize retaining wall as three-dimensional curved surface. The validity was confirmed by the simulation of the loading test on the model wall and actual monitoring from the on-site measurement. It proposed to conduct monitoring of retaining walls using this analytical method and simple inclinometers. The paper describes original research/application and would be interested to most researchers.

Paper 2669 "Geotechnical protection of engineering infrastructure objects in large cities under intense anthropogenic impact and long term operation" by Perminov, Zentsov, Perminov, Russia. This article describes more than 30-year experience of scientific and technical support, design, construction and reconstruction of water supply and sewage facilities in St. Petersburg, Sochi, etc. It includes experience of sinking of large diameter shaft/caisson and long term loadings on tunnels in urban areas. Could do with a thorough proof reading and some of the terms used are unfamiliar. It is recommended for Panel presentation as it will be of interest to those who would like to practice in Russia.

Paper 2535 "A geoenvironmental application of an optimisation model" by Azimi, Merrifield, Gallagher & Smith from UK. The paper summaries a network of monitoring wells installed in and around a refinery in mid 1990s as part of a research project aiming to investigate the impact of local groundwater on corrosion of buried foundations and underground storage facilities. A second research project was started in 2000 to delineate the extent of the oil contamination mound(s) beneath the refinery and devise appropriate remedial measures. This paper presented an optimisation technique which assisted with augmentation of the monitoring network, thereby the cost-effective delineation of the oil mounds beneath the refinery. An optimisation model, The Maximal Covering Location Problem (MCLP), was modified and applied to find the optimum number and locations of additional monitoring wells to assist with the cost-effective delineation of the oil contamination mound beneath the refinery.

It is recommended for panel presentation as it may provide further discussions on the degree of confidence in selection of the value of maximal service distance (S) in the order of 100m without consideration of field, laboratory and theoretical investigations.

Paper 2460 "Evaluation of diaphragm wall as-built data to determine the risk of leakage for the Kruisplein car park excavation in Rotterdam, The Netherlands" by Hannink & Thumann from Netherlands. This paper should give the geological profile of the site to let readers have a better understanding of the ground conditions. Representative pumping test results may be included to demonstrate the critical or potential locations of leakage and the contingency measures which shall be required. It is recommended for Panel presentation.

Papers 3083 "Preventive maintenance of water retaining structures based on fiber optic systems" by Fry, Courivaud, Beck & Pinettes from France. The Pare described that EDF develops the concept of preventive maintenance. It means design, building and operation of an early warning monitoring system (leakage and strains), plus model of interpretation and portfolio of technical or legal alarm and interventions. In that framework, EDF has been working since 1994 on the development of the use of the distributed measurements with fiber optic, to improve the monitoring of dykes and flood embankments. The fiber optic technology provides a remote control measurement of the distributed temperature and strain every meter along the embankment. This new technology strategically placed in the fill, allows to reinforce the hydraulic and mechanical behavior monitoring, which is provided to date by conventional instrumentation (leveling, piezometer, discharge rate), with simultaneously a global and detailed surveillance and an early warning system for extreme loadings and crisis (floods, earthquakes, vandalism). It introduces the principle of dikes monitoring using fiber optic and the validation results of this technology from both trial test sites and on EDF's real sites.