Talk on 'Advantages and Pitfalls of Finite Element Analysis in Geotechnical Engineering Practice'

by ***Ir. Chua Chai Guan,*** *MIEM, P. Eng.*

THE talk on 'Advantages and Pitfalls of Finite Element Analysis in Geotechnical Engineering Practice' was delivered by Ir. Dr Dominic E.L. Ong on 15 July 2009 at 5.30 p.m. at the Chin Fung Kee Auditorium Hall, Wisma IEM. The talk was attended by about 35 participants.

Ir. Dr Ong began his talk by introducing the key factors that can affect finite element analysis (FEA) results. They are

(i) soil models and parameters adopted;
(ii) boundary conditions;
(iii) FE meshes and *in situ* stress;
(iv) interface or slip elements;
(v) idealised structural element;
(vi) interface or slip elements (wall, struts, application of preload, *etc*) and
(vii) construction method or sequence.

Ir. Dr Ong pointed out that with the assistance of FEA; the understanding of soil-structure interaction for excavation projects was vastly enhanced. Thus the associated risks can be established. He also demonstrated the capabilities and limitations of each type of FEA software through a simulation of pile behaviours and triaxial test using FEA. However, he cautioned that FEA should be used with proper understanding (rubbish in rubbish out). The consequence of inadequate design using FEA could be disastrous.

Ir. Dr Ong presented a case study involving the use of elastic-perfectly plastic Mohr-Coulomb soil model to model soft clays. The consequence is that the soil strength has been artificially over-predicted, thus causing the serious under-prediction of forces acting on the temporary works which led to the under-design of temporary works in general.

The speaker also pointed out that engineering experience, judgment, the fundamental knowledge and understanding of theoretical soil mechanics are important ingredients in shaping a responsible and experienced FEA user. The confidence level of a FEA user can be increased via benchmarking of FEA quantitatively and qualitatively.

Quantitative benchmarking involves (i) software vs. software, (ii) software vs. reliable field data and (iii) software vs. reliable laboratory experimental data, which are often used to produce closed-form and analytical solutions, while qualitative benchmarking involves software vs. experience and judgment. The exercise of benchmarking would help users to understand the capabilities and limitations of the FE software, as well as the complexity of the soil-structure interaction problem beyond normal means. More importantly, this can avoid construction disaster.

Ir. Dr Ong during his presentation

Ir. Dr Ong also presented three geotechnical engineering case studies that he has worked on before, namely, FE analyses associated with (i) deep excavation, (ii) pile-soil interaction and (iii) embankment and dam construction.

Due to the advancement of computing power, Ir. Dr Ong foresaw that the future of FEM in geotechnical engineering is with 3D modelling. With the 3D feature, the FEA will be able to more accurately simulate vertically & laterally loaded pile group, pile-raft foundation, tunnel excavation, structures on slope, complex soil structure interaction and quay walls. ■