One Day Short Course on FEM in Geotechnical Engineering
by Ir. Dr Gue Chang Shin

Ir. Dr Gue Chang Shin is a currently the Secretary/Treasurer in Geotechnical Engineering Technical Division (GETD).

It was an honour for the Geotechnical Engineering Technical Division (GETD) of IEM, to have Assoc. Prof. Er. Dr. Harry Tan Siew Ann of the National University of Singapore (NUS), to deliver the short course at the Hotel Armada Petaling Jaya on 11th July 2018. The short course was attended by 105 participants.

The short course on Finite Element Modelling (FEM) in Geotechnical Engineering covered the following areas:

- Basics of FEM soil modelling, elasticity versus plasticity
- Mohr Coulomb versus Hardening Soil and Soft Soil Creep models
- Determination of soil parameters (CID and Oedometer tests)
- Pitfalls of FEM analyses
- Drained and undrained analyses
- Advanced model for cement treated soil (Shotcrete Model)

Assoc. Prof. Harry Tan began the first session by laying out that the basic solution requirements for typical geotechnical analyses, such as equilibrium, compatibility, constitutive behaviour and boundary conditions. When FEM is properly used, this method can produce realistic results which are important to practical soil engineering problems. Some requirements for successful numerical modelling include:

- Construction of an adequate conceptual model that includes the basic features of the model. The model should be as simple as possible but not simpler.
- Selection of an appropriate constitutive model. It depends on type of soil or rock, goals of the analysis, quality and quantity of available information.
- Pay attention to patterns of behaviour and mechanisms rather than just on quantitative predictions.
- Perform sensitivity analyses. Check robustness of solutions.
- Model calibration (using field results) should be a priority, especially if quantitative predictions are sought.
- Check against alternative computations if available (even if simplified).

The characteristics of various soil models were discussed, and the limitations for each soil models were covered in detail. Comparisons of various soil models were also made, where the advantages and disadvantages of each soil models were presented. The speaker highlighted that the Hardening Soil model is better suited for non-linear formulation of soil behaviour in general (both soft soils and harder soil types) as compared to the Mohr-Coulomb model. However, the Hardening soil model does not capture creep (secondary compression behaviour). Whereas the Soft Soil Creep model is able to capture the creep or time dependent deformations; however, it is only suitable for soft soils and not for other soil types.

Assoc. Prof. Harry Tan moved on to drained and undrained soil behaviours and the methods of analysis in FEM. Drained analyses are appropriate when soil permeability is high, rate of loading is low and short-term behaviour is not of interest; while undrained analyses are appropriate when soil permeability is low and rate of loading is high, where short term behaviour has to be assessed. Various methods of analyses for undrained behaviour were presented and the speaker stressed that there is no one method that is always correct as it depends on soil conditions and applications.

The last session of the short course was on an advanced model for cement treated soil known as the Shotcrete Model. The model is able to simulate behaviour of time dependent material properties, strain hardening & softening behaviours in tension and compression, creep as well as shrinkage. This model is applicable for tunnelling, concrete and shotcrete with time dependent properties during hydration and other cement-based soil materials. The speaker presented some of the applications and a case study of lateral load test of soil cement column to showcase the capability of the model. Figure 1 shows the example of 3D analyses of a field case study using this advanced model.

Assoc. Prof. Harry Tan concluded that Geotechnical Engineering is complex. It does not mean a problem becomes simpler when using FEM. A good analysis, which simulates real behaviour, allows engineer to understand problems better. The quality of a tool is no doubt important; however, the quality of a result also depends on the user's understanding of both the problem and the tool. The course ended with rounds of applause from the audience and a token of appreciation was presented by the Session Chairman, Ir. Dr. Gue Chang Shin to Assoc. Prof. Harry Tan (Figure 2).

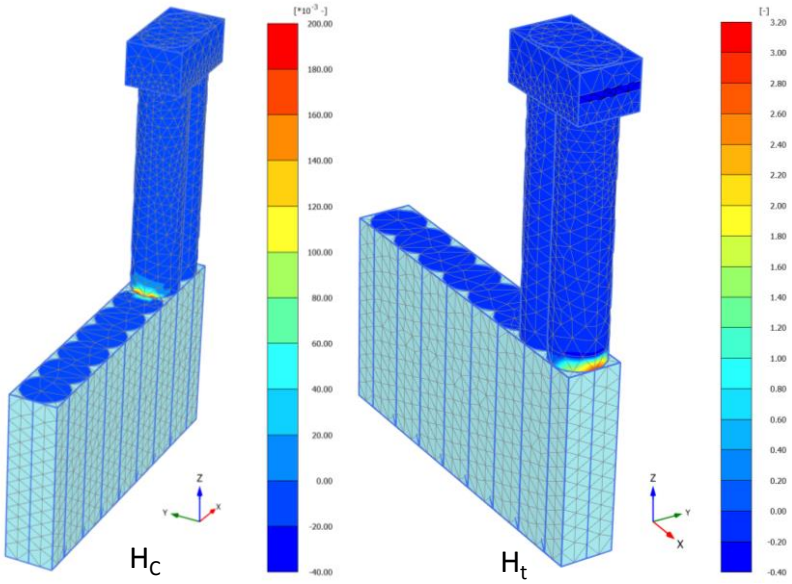

Figure 1: 3D FEM analyses using *normalised compression hardening and normalised tension softening parameters*

Figure 2: Appreciation momento presented by the Session Chairman Ir. Dr. Gue Chang Shin to Assoc. Prof. Harry Tan