Application of new observational method on deep excavation retaining wall design in London Clay

by
Ying Chen

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Abstract

Ground engineering in urban areas faces the great challenge of balancing increasing demand for underground space against safety and asset protection while avoiding high construction costs. This study shows savings can be achieved on embedded retaining wall design for deep excavation in London Clay without compromising safety.

Despite the inherent benefits of the method and its acceptance by design codes, the application of the observational method for excavation design has been slow and inconsistent due to the lack of guidance, in addition to other difficulties.

This research aims to promote the application of the observational method in excavation design by proposing a new framework. The framework with four design approaches is established based on the review of historical excavation case histories and four Crossrail station excavations using the observational method. The term *Ab initio* is used for excavation design from the beginning of construction, covering Optimistic Approach A and Cautious Approach B. The term *Ipso-tempore* is introduced for excavation redesign after construction starts, comprising a newly defined Pro-active Approach C and the '*best-way-out*' or Reactive Approach D.

Back-analysis is critical in the observational method. The whole process of back analysis is examining monitoring systems (observations) and predictions by the numerical analysis and soil constitutive models. The Crossrail Tottenham Court Road Station, Western Ticket Hall deep box excavation was back-analysed by the semi-numerical model, 2D and 3D FEM models. The results are presented for two adopted soil models: the Mohr-Coulomb model and the BRICK model. The different results indicate the back-analysis is subject to the type of numerical analysis and the adopted soil constitutive model, also it needs to be tailored to the monitoring data used for comparison.

The sets of most probable design parameters for London Clay were calibrated for both the Mohr-Coulomb model and the BRICK model, through the back-analyses for the TCR-WTH case and validated in other three Crossrail excavations. A reassessment of the TCR-WTH excavation design carried by Approach A using the semi-numerical model with the most probable Mohr-Coulomb parameters for London Clay, shows over 30% saving in construction materials and potential saving in construction time if the excavation does not encounter unexpected conditions.

Improvements of specifications for the instruments and monitoring data are recommended to provide more reliable monitoring data.

Thesis Supervisor: Dr Giovanna Biscontin