Abstract

Advancements in tunnelling technologies in recent years have made tunnelling construction possible even in poor soil conditions, encouraging more tunnels to be built in congested urban areas to meet the ever increasing transportation demand and to ease traffic congestions. This inevitably results in new tunnels being built in close proximity. Therefore it is crucial to investigate and understand the extent and magnitude of tunnelling imposed strains on the existing tunnel from a tunnelling design and asset protection perspective.

This thesis is aimed at identifying deformation mechanisms which governs the response of an existing tunnel in clay when subjected to a new tunnel construction directly below it in a parallel and perpendicular undercrossing alignment. Effects of clear distance are of particular interest where the tests were carried out at a very close clear distance of 0.5 to 1.5 diameters between tunnels for each scenario.

This research combines the approach of centrifuge modelling which allowed the response of the tunnels to be studied in a controlled environment at realistic stress levels and compares it with state-of-the-art distributed fibre optic strain monitoring data from two field instrumentations of similar scenarios. Centrifuge tests incorporated an innovative multi advancement staged volume loss tunnels to allow quasi three dimensional tunnelling effects to be captured in a bespoke centrifuge package.

A semi empirical approach to assess cross sectional bending moments of the existing lining was proposed based on mobilised strength design of a non-linear elastic perfectly-plastic soil model. Evidence from both centrifuge tests and field data have also validated the used of a closed form Winkler spring solution for pipeline longitudinal bending moments assessment with an extension to include axial strain component. Outcome of this research is envisaged to serve as a foundation for future improvements for a comprehensive predictive model.