Imperial College London

Effects of tunnelling on existing tunnels

A half-day seminar to disseminate and discuss findings from the Imperial College Crossrail research project

Time and date: **13:00, Wednesday 25th April 2018**
Venue: **Room 164 (ground floor), Dept. Civil & Environmental Engineering, Skempton Building, Imperial College, London SW7 2BU**

During the period from 2010 to 2014 and beyond Imperial College undertook an extensive research programme to investigate the effects of tunnelling on existing tunnels. The study was initiated from earlier fieldwork undertaken by the research group during the construction of the Jubilee Line Extension (JLE), written up by Standing and Selman (2001), and two case studies concerning new tunnels being constructed beneath existing ones: in one case the bolts of the existing tunnel were loosened (Kimmance et al., 1996) and in the other they were tightened (Moss and Bowers, 2006). The former approach mitigates the development of bending moments in the lining, but at the expense of uncontrolled displacements and the latter the converse.

The study was funded by EPSRC (EP/G063486/1), Crossrail and Morgan Sindall and was run in conjunction with the Crossrail project. There was a specific focus on grey cast iron (GCI) segmental linings, often used in the construction of the older more sensitive tunnels, some of which were affected by the construction of the new tunnels. The research was tackled through five inter-related primary paths: (i) structural testing of half-scale GCI segments (coupled and in rings); (ii) numerical analysis of the structural testing; (iii) field monitoring of the ground and the existing Central Line tunnels (at Hyde Park / Lancaster Gate); (iv) numerical modelling of the field conditions; and (v) advanced laboratory testing of high quality samples taken during installation of field instrumentation in Hyde Park (note that this final topic is not covered in this seminar).

Many of the findings have been disseminated in the form of papers, as listed overleaf. The intention of the seminar is: (i) to draw attention to the key findings of the work and implications for future design and analysis of tunnels; and (ii) to exchange views and contributions from those interested in tunnelling both from industry and academia. The presentations are to be given by some of those involved with the project.

13:00 – 13:20 – Registration
13:20 – 13:30 – Introduction – Jamie Standing
13:30 – 15:30 – *Structural testing and analysis*
- 13:30 – 14:00 – Two-segment testing and analysis – Jessica Yu & Katerina Tsiampousi
- 14:00 – 14:30 – Full-ring tests – elastic response at small displacements – Jessica Yu
- 14:30 – 15:00 – Full-ring tests to failure – Sheida Afshan
- 15:00 – 15:30 – Discussion on structural testing and analysis

15:30 – 16:00 – Tea break
16:00 – 18:00 – *Field monitoring and numerical analysis of ground and tunnel response to tunnelling*
- 16:00 – 16:30 – Field monitoring in Hyde Park – Michael Wan
- 16:30 – 17:00 – Monitoring within existing tunnels – Jamie Standing
- 17:00 – 17:30 – Numerical modelling of field conditions/response – Vasilis Avgerinos

17:30 – 18:00 – Discussion on the geotechnical aspects and summing up

Please note that the event is free but if you plan to attend please email Sue Feller at least a week in advance so that we have an idea of numbers: s.feller@imperial.ac.uk

Structural testing and analysis

Afshan, S., Yu, J.B.Y., Standing, J.R., Vollum, R.L. and Potts, D.M. (2017). Ultimate capacity of a segmental grey cast iron tunnel lining ring subjected to large deformations. *Tunnelling and Underground Space Technology*, Vol. 64, pp 74-84.

Standing, J.R. and Lau, C. (2017). Small-scale model for investigating tunnel lining deformations. *Tunnelling and Underground Space Technology*, Vol. 68, pp. 130-141.

Tsiampousi, A., Yu, J., Standing, J.R., Vollum, R. and Potts, D.M. (2017). Behaviour of bolted cast iron joints. *Tunnelling and Underground Space Technology*, Vol. 68, pp 113-129.

Yu, J., Standing, J.R., Vollum, R., Potts, D. M. and Burland, J.B. (2015). Stress and strain monitoring at Tottenham Court Road Station, London, UK. *Proc. ICE – Structures and Buildings*, Vol. 168, No. SB2, pp 107 – 117.

Yu, J., Standing, J.R., Vollum, R., Potts, D.M. and Burland, J.B. (2017). Experimental investigations of bolted segmental grey cast iron lining behaviour. *Tunnelling and Underground Space Technology*, Vol. 61, pp 161-178.

Field monitoring

Fearnhead, N., Maniscalco, K., Standing, J.R. and Wan, M.S.P. (2014). Deep excavations: monitoring mechanisms of ground displacement. *Proc. ICE – Geotechnical Engineering,* Vol. 167, GE 2, pp 117-129.

Hauswirth, D., Puzrin, A.M., Carrera, A., Standing, J.R. and Wan, M.S.P. (2014). Application of fibre optic sensors for simple assessment of ground surface displacements during tunnelling. *Géotechnique,* Vol. 64, No. 10, pp. 837 – 842.

Wan, M.S.P. and Standing, J.R. (2014). Lessons learnt from installation of field instrumentation to monitor ground response to tunnelling. *Proc. ICE - Geotechnical Engineering*, Vol. 167, No. GE5, pp 491–506.

Wan, M.S.P. and Standing, J.R. (2014). Field measurement by fully grouted vibrating wire piezometers. *Proc. ICE - Geotechnical Engineering*, Vol. 167, No. GE6, pp 547–564.

Wan, M.S.P., Standing, J.R., Potts, D.M. and Burland, J.B. (2017). Measured short-term ground surface response to EPBM tunnelling in London Clay. *Géotechnique,* Vol. 67, No. 5, pp. 420-445.

Wan, M.S.P., Standing, J.R., Potts, D.M. and Burland, J.B. (2017). Measured short-term subsurface ground displacements from EPBM tunnelling in London Clay. *Géotechnique*, Vol. 67, No. 9, pp. 748-779.

Wan, M.S.P., Standing, J.R., Potts, D.M. and Burland, J.B. (2018). Pore water pressure and total horizontal stress response to EPBM tunnelling in London Clay. Submitted to and under review for *Géotechnique*.

Numerical analysis

Avgerinos, V., Potts, D.M. and Standing, J.R. (2016). The use of kinematic hardening models to predict tunnelling-induced soil movements in London Clay. *Géotechnique,* Vol. 66, No. 2, pp 106 – 120.

Avgerinos, V., Potts, D.M. and Standing, J.R. (2017). Numerical investigation of the effects of tunnelling on existing tunnels. *Géotechnique,* Vol. 67, No. 9, pp. 808-822.

Avgerinos, V., Potts, D.M., Standing, J.R. and Wan M.S.P (2018). Predicting tunnelling-induced ground movements and interpreting field measurements using numerical analysis: Crossrail case study at Hyde Park. *Géotechnique,* Vol. 68, No. 1, pp. 31-49.

Laboratory soil testing

Ackerley, S.K., Standing, J.R. and Hosseini Kamal, R. (2016). A system for measuring local radial strains in triaxial apparatus. *Géotechnique,* Vol. 66, No. 6. pp 515 – 522.