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Modelling the Pre-Yielding Behaviour of London Clay

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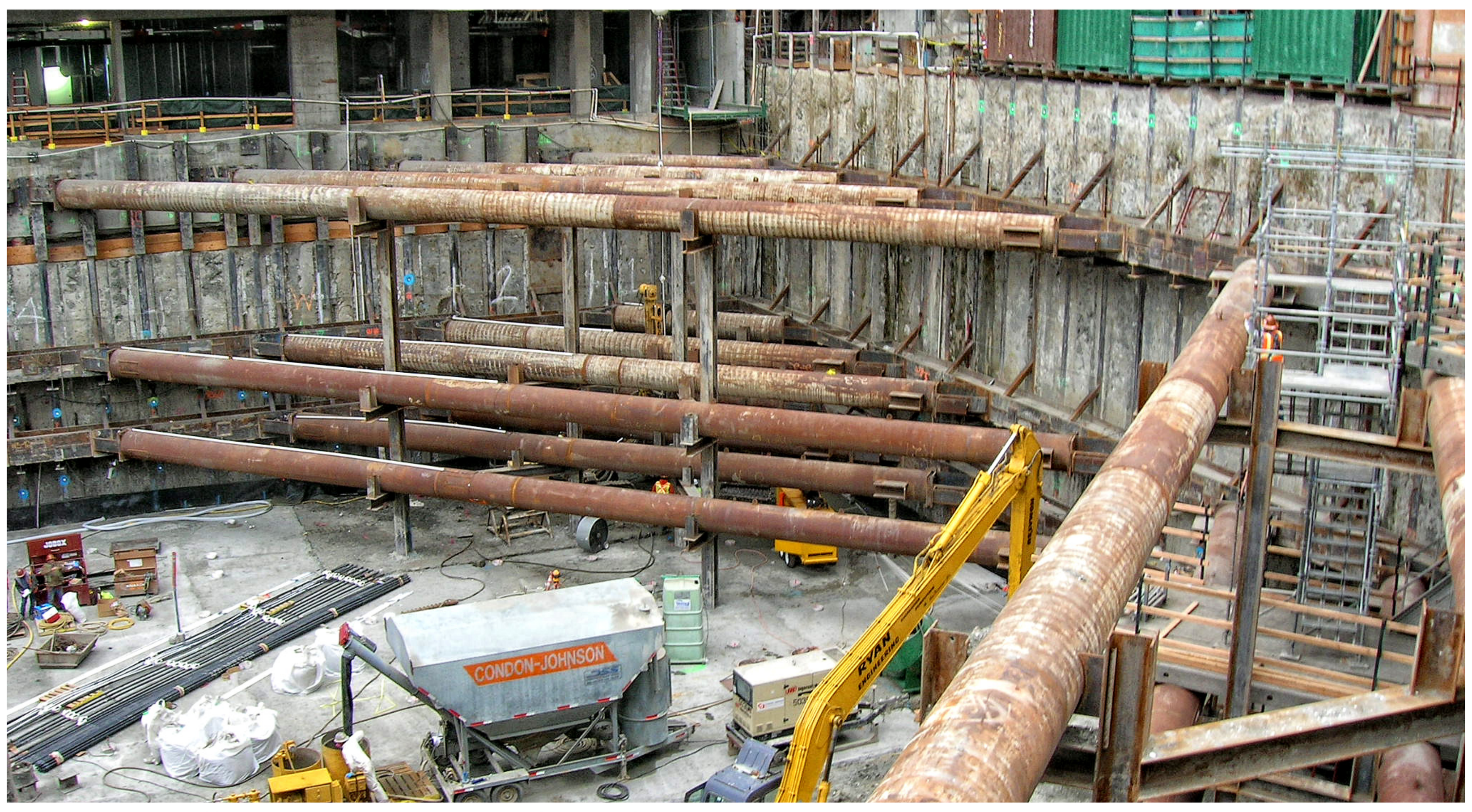
INTRODUCTION

Employing an appropriate constitutive model is of the essence in numerical analyses of the serviceability limit states of geotechnical structures. It is well known that the widely used Non-Linear Mohr Coulomb model (NMC) combined with Jardine et al. (1986) small-strain stiffness model does not fully describe all aspects of real behaviour of London Clay. This motivates the objective of this study: to calibrate and employ a more advanced model for London Clay in numerical analyses, the Extended Modified Cam Clay combined with the Imperial College Small Strain Stiffness model. Two case studies, namely the Jubilee Line Extension at St. James' Park and the Moorhouse deep excavation, are carried out to assess the difference in the prediction of ground response by the two models.

Source: http://www.bcd-urbex.com/camden-rat-hole-london-underground-tunnel/



Source: http://www.panoramio.com/photo/18202635

CALIBRATION & FINITE ELEMENT ANALYSIS

Calibration of the model is done against existing triaxial experiments data. Four data sets are used for the calibration to calibrate the small-strain-stiffness model: "Previous Stiff & Soft", T5 and Hyde Park Data. Imperial College Finite Element Program (ICFEP) (Potts & Zdravkovic, 1999) has been used to analyse two case studies. The numerical method used was the coupled consolidation plane strain analysis.

CASE STUDY 1

The first case study is the westbound (WB) and eastbound (EB) tunnel excavation for the Jubilee Line Extension at St. James' Park. Both tunnels are found on London Clay.

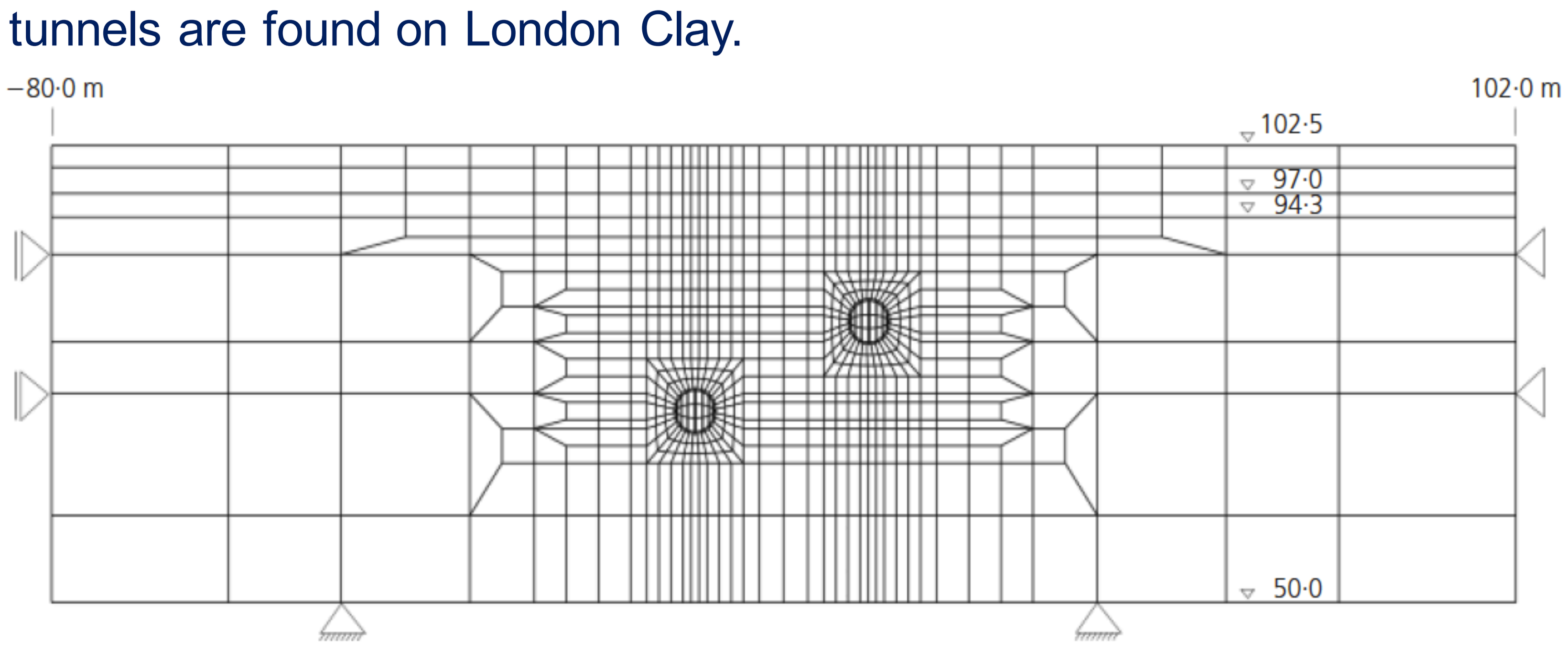


Figure 1: Finite Element Mesh for Case Study 1 (Jurečič et al. 2012)

ACKNOWLEDGEMENTS

I would like to express my gratitude to my supervisor: Professor Lidija Zdravković and to Dr. Tarborda for their guidance throughout this research project.

CASE STUDY 2

The second case study is the Moorhouse deep excavation at Moorgate in London which is part of the Crossrail project as it acts as a launching chamber for the Crossrail tunnel excavation and also a station hall in the future. The excavation is separated in stages and after each stage a prop is installed to resist wall movements.

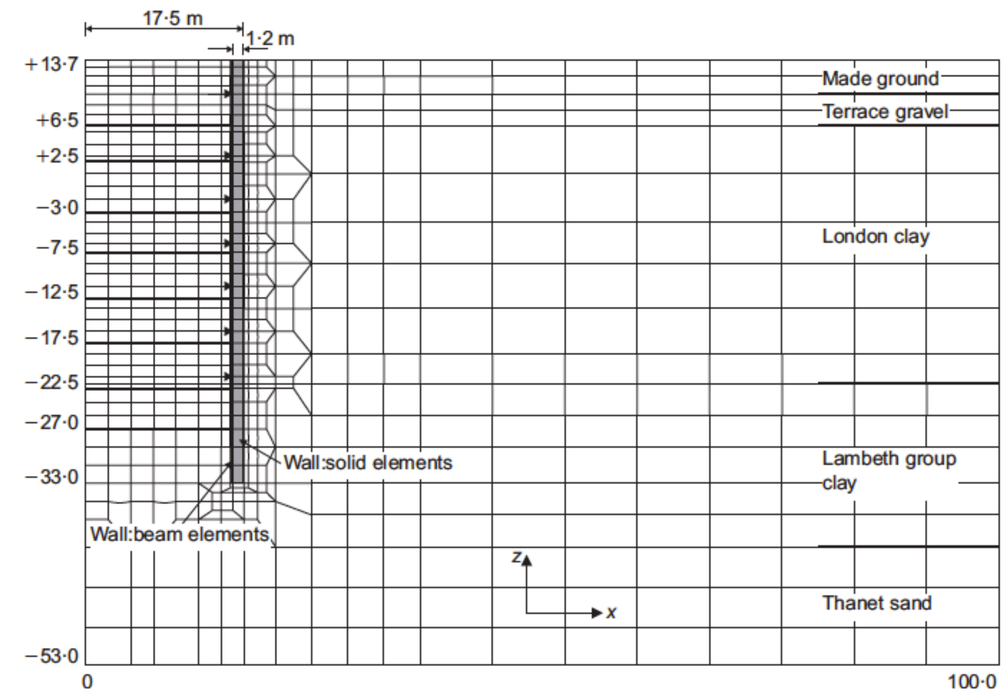


Figure 2: Finite Element Mesh for Case Study 2 (Zdravković et al., 2005)

RESULTS – SHORT-TERM (CASE STUDY 1)

The short-term response is assessed right after each tunnel excavation. The response is undrained as small time steps are prescribed. Therefore, the shear stiffness is the dominant factor in the short-term ground response.

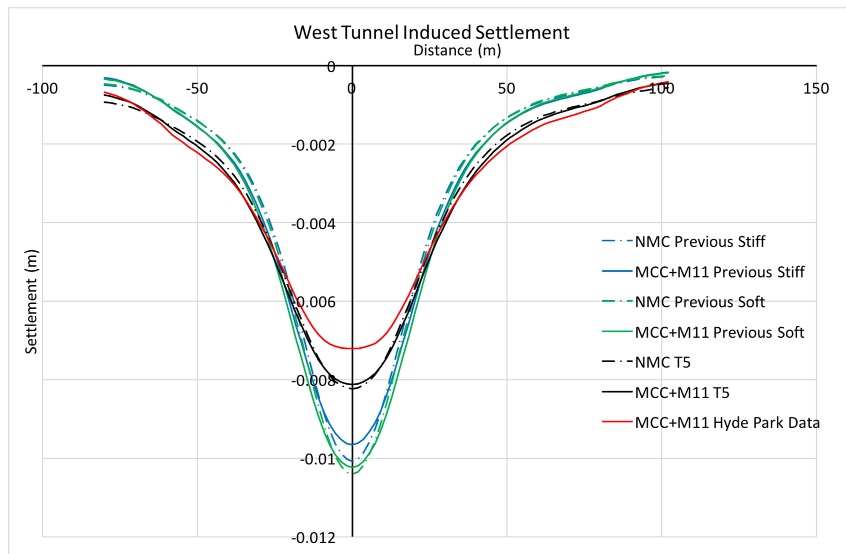


Figure 3: Ground Settlement: WB Excavation

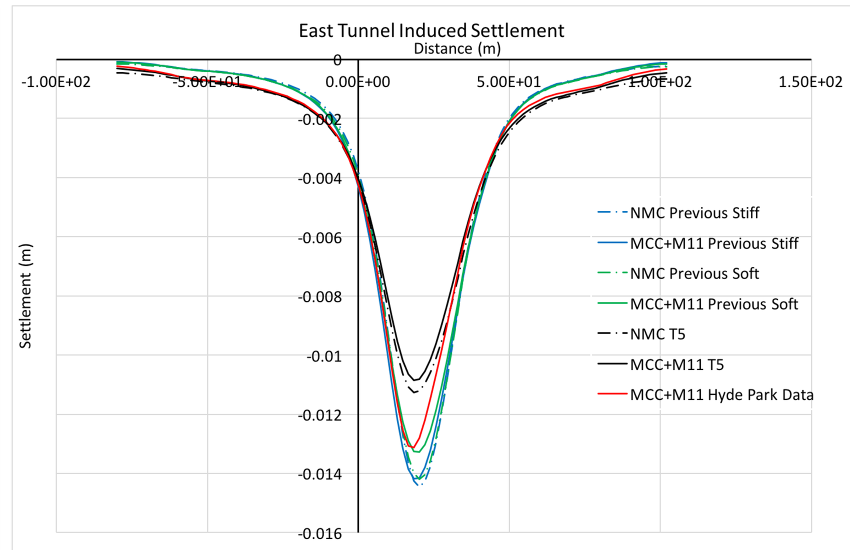


Figure 4: Ground Settlement: EB Excavation

RESULTS – LONG-TERM (CASE STUDY 1)

The long-term response is assessed after both tunnels excavation and after all excessed pore water pressure is dissipated. Therefore, the bulk stiffness is the dominant factor in the long-term ground response because the volume change is important in the long-term as the soil consolidates.

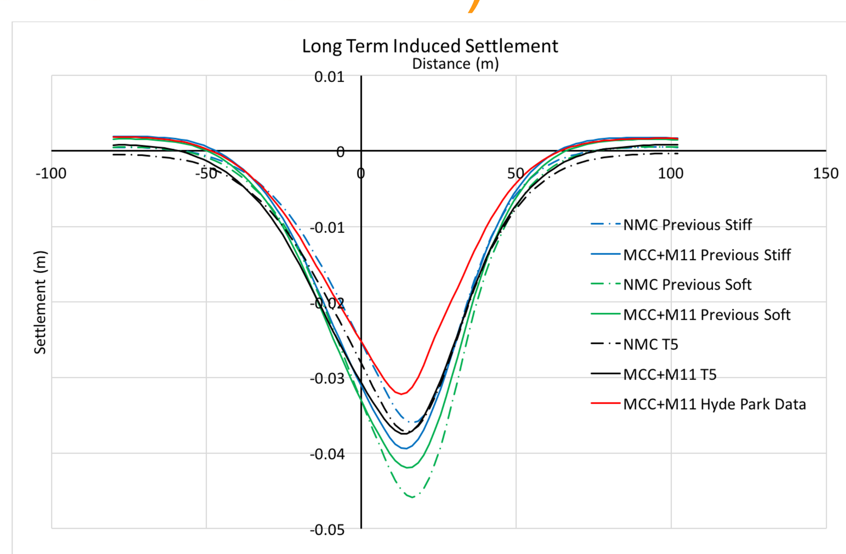


Figure 5: Ground Settlement: Long-term

RESULTS – SHORT-TERM (CASE STUDY 2)

The short-term response studied includes the wall movement and ground settlement behind wall for after the final stage of excavation.

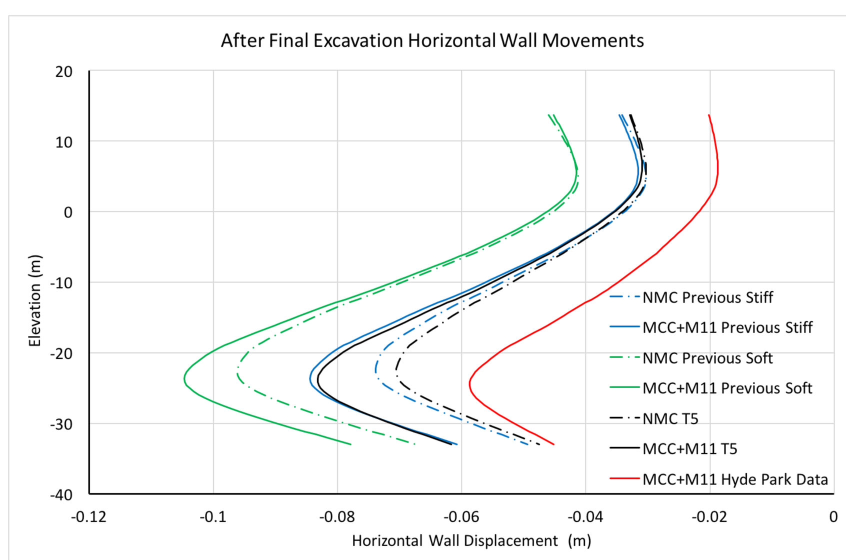


Figure 6: Short-Term Wall Movement

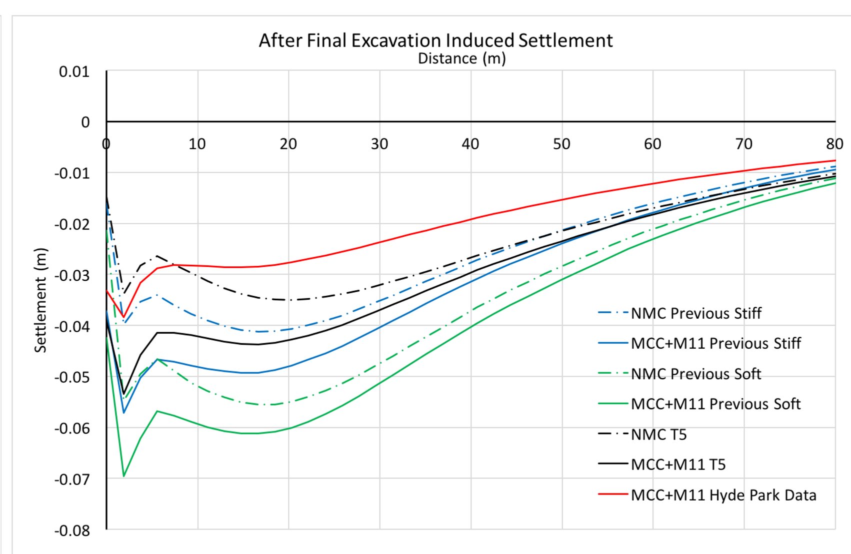


Figure 7: Short-Term Wall Movement

RESULTS – LONG-TERM (CASE STUDY 2)

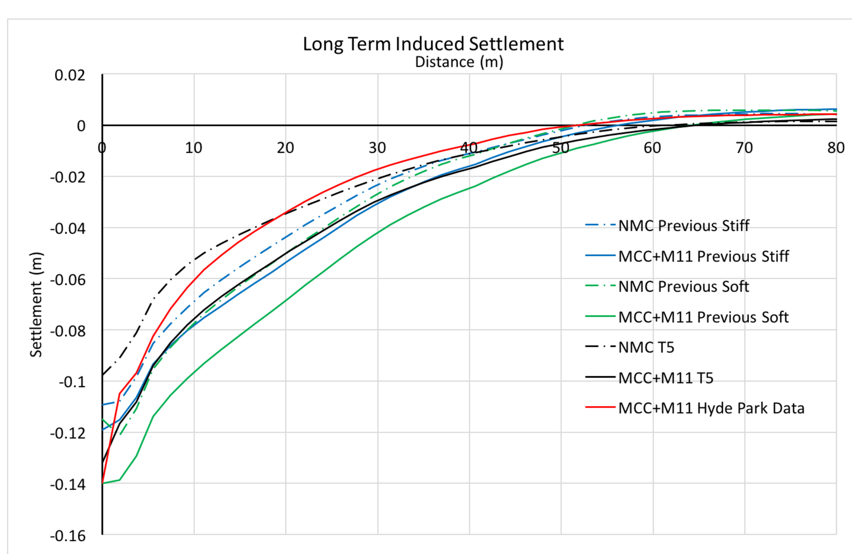


Figure 8: Long-Term Wall Movement

CONCLUSION

- Case Study 1: Smaller differences between 4 data sets. Slightly stiffer response for chosen model vs NMC
- Case Study 2: Larger differences between 4 data sets. Softer response for chosen model
- Post-yielding behaviour is unimportant for both case studies signifying that NMC is a sufficient model for these cases

REFERENCES

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