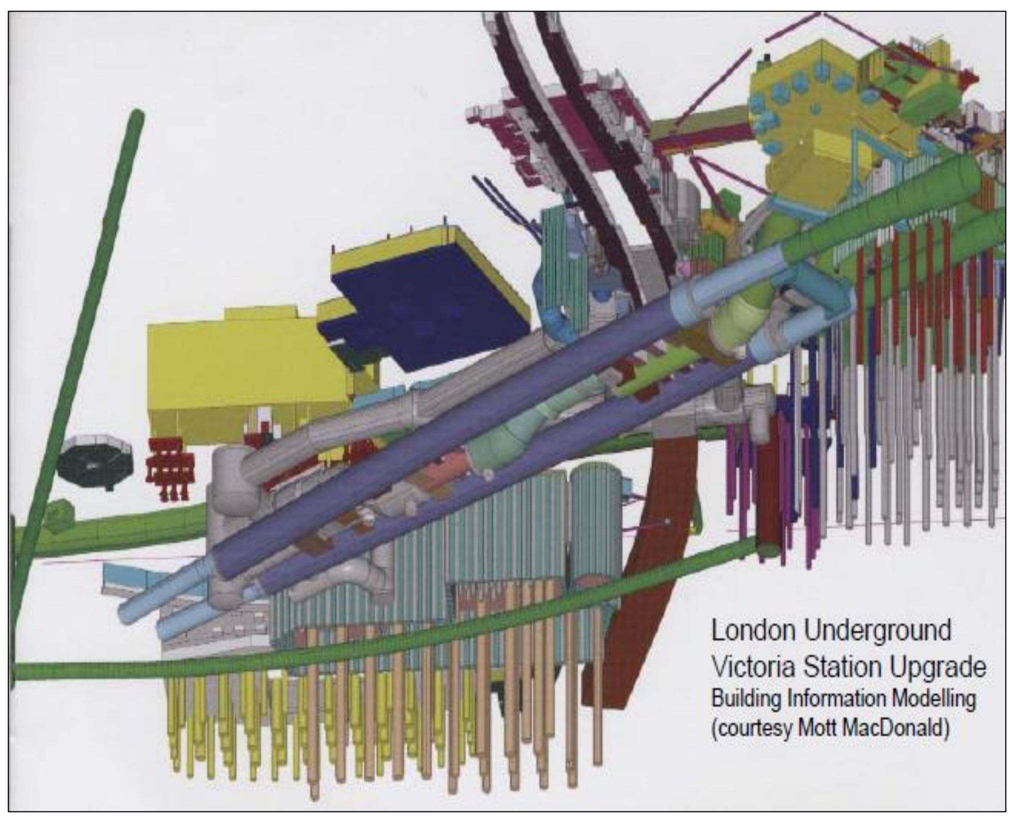
Physical and numerical modelling of tunnelling below piled foundations in soft clay

Ahmed Alagha (asna2@cam.ac.uk) Supervisor: Prof. Giulia Viggiani

UNIVERSITY OF CAMBRIDGE
Department of Engineering

GEO ENV

1. Motivation



In the urban environment the underground space is often very crowded, hence the construction of new tunnels near piled foundations is unavoidable.

Piles transfer the loads from the superstructure to the ground thus **producing stresses** in the surrounding soil. Tunnelling is **a stress relief process** that generates **vertical and horizontal** ground movements.

Vertical soil movements induce settlements and additional axial load on the piles, and **a potential reduction** in the pile load capacity.

Horizontal soil movements impose **lateral deflections** as well as **bending moments** along piles.

2a. Methods - physical modelling

To reproduce the **physical phenomena** happening around the shield, a miniature **EPB TBM** has been designed and assembled to be used in the **geotechnical centrifuge**.

Similar to a real TBM, the proposed machine consists of **six primary components:**

(1) a **cutterhead** to cut and excavate the soil

(2) a **screw conveyor** to extract the soil

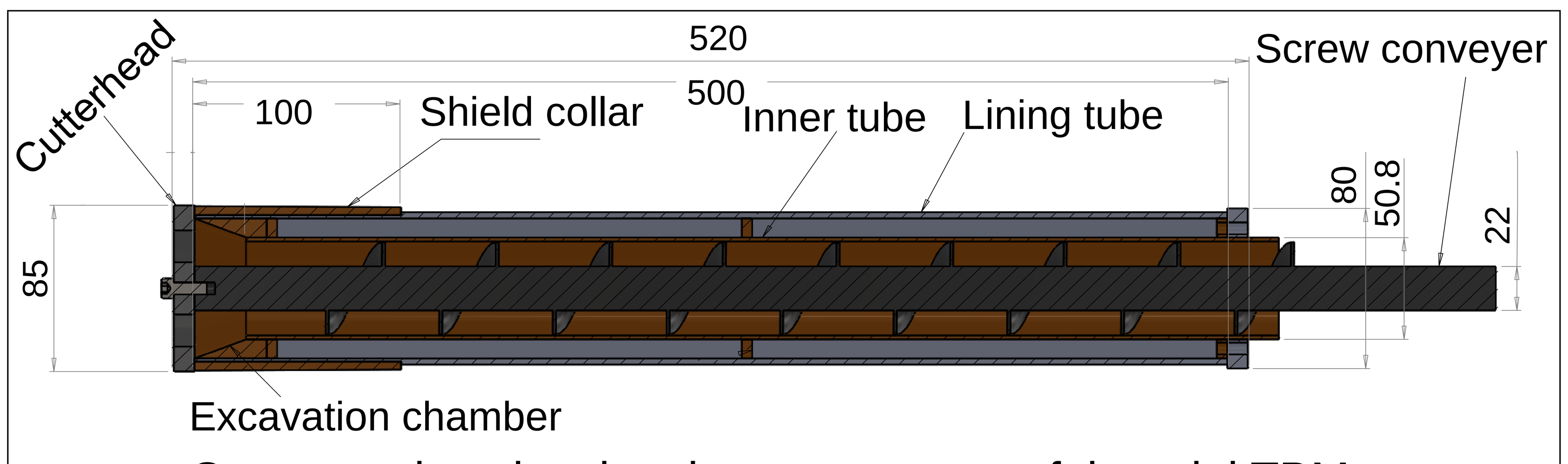
(3) an **inner brass tube** to host the auger

(4) an **outer tube** to simulate the lining

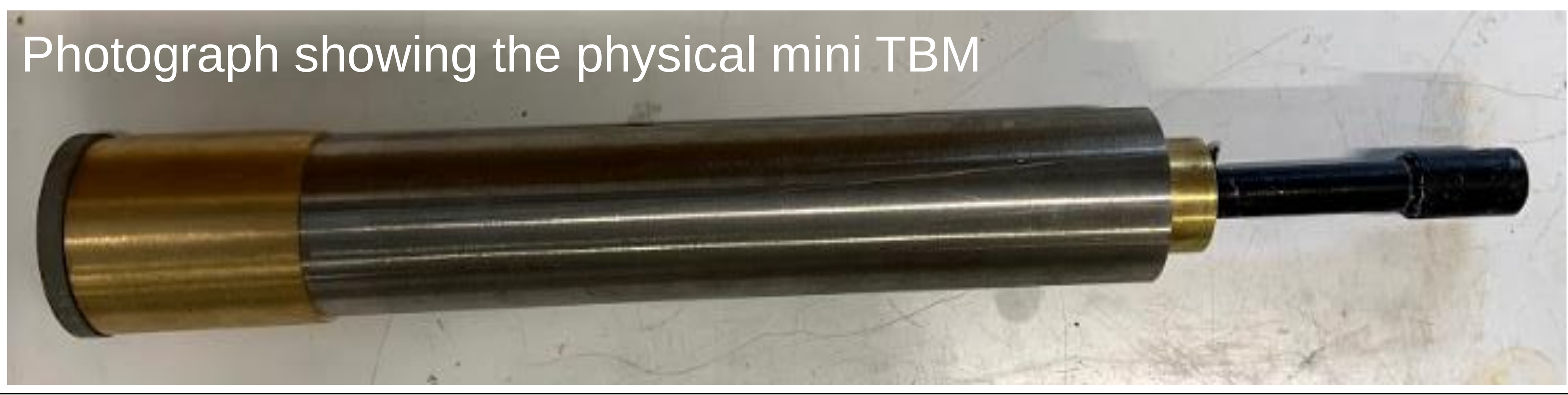
(5) a **shield collar** to simulate the TBM body

(6) an **excavation chamber**

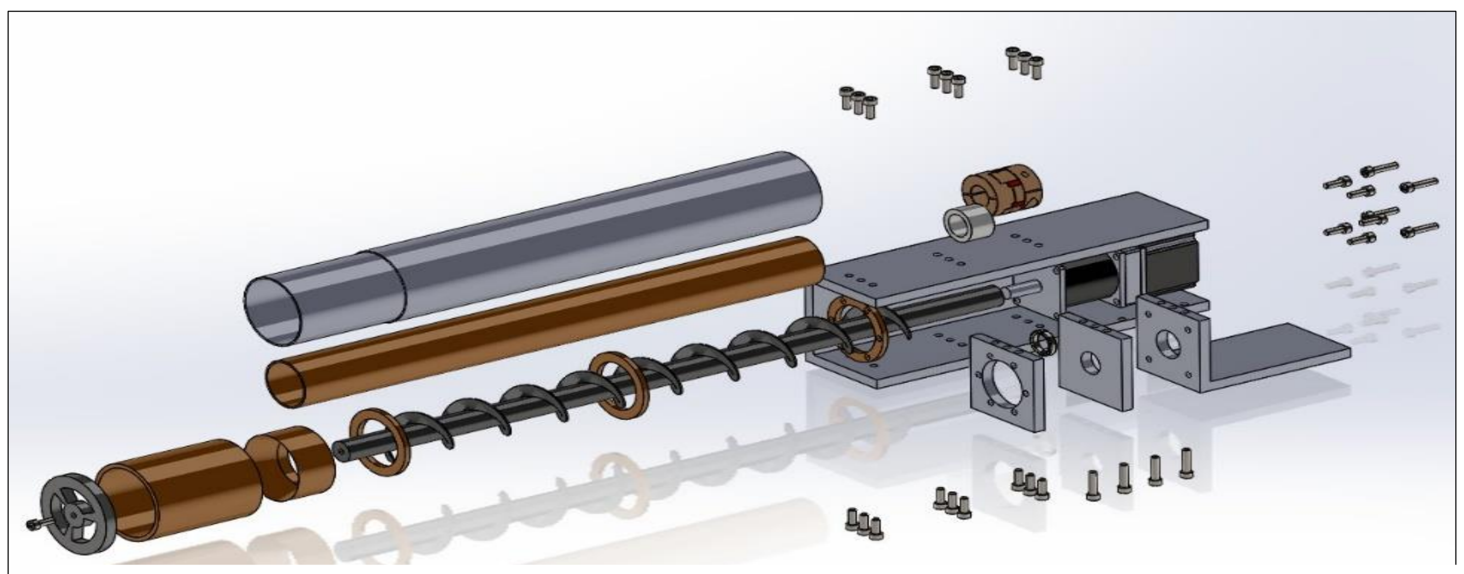
A **drive system** comprising a **motor** to drive the auger and an **actuator** is used to advance the TBM.



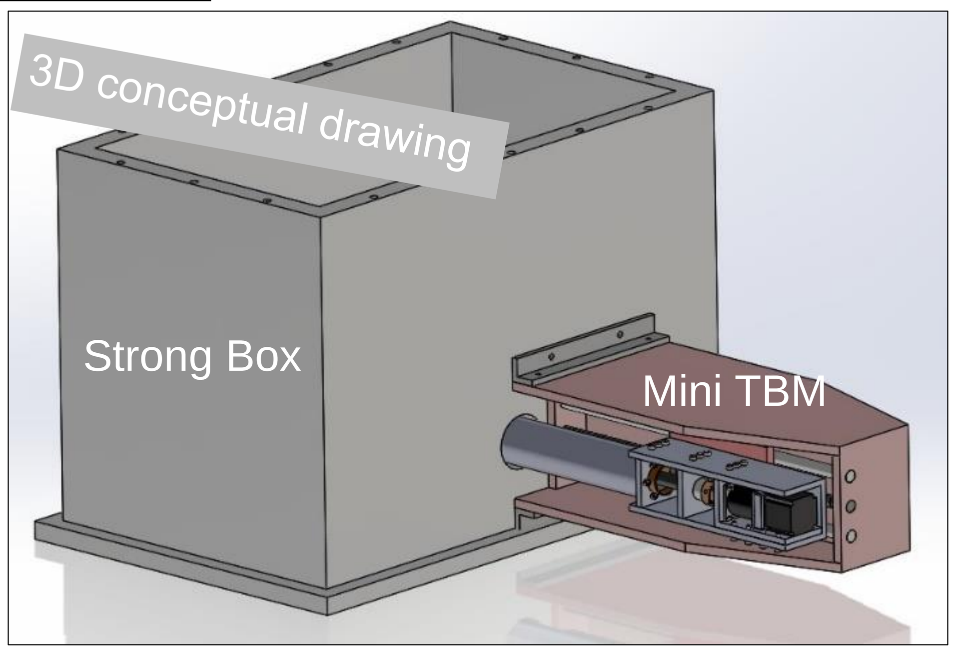
Cross-section showing the components of the mini TBM



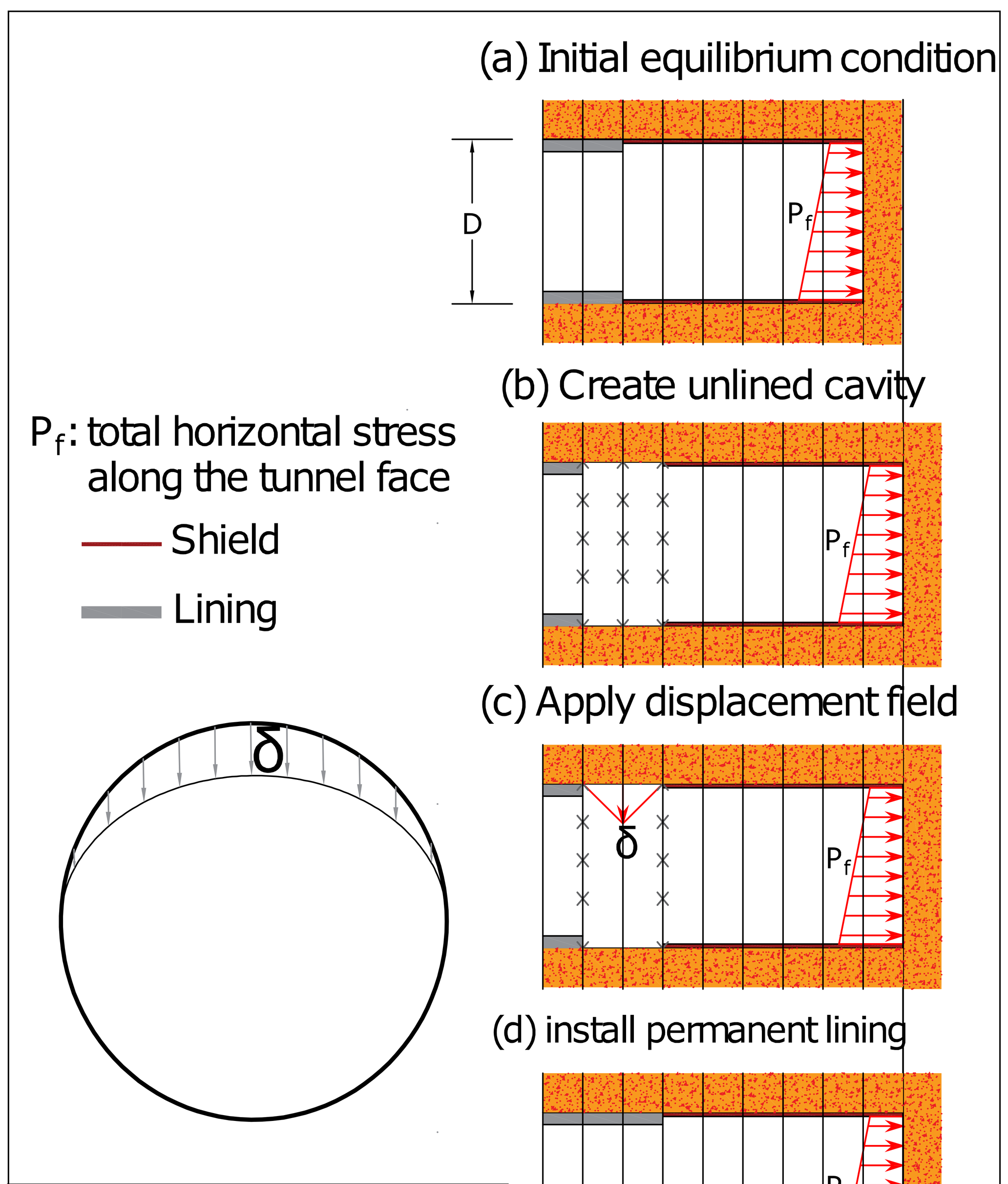
Photograph showing the physical mini TBM



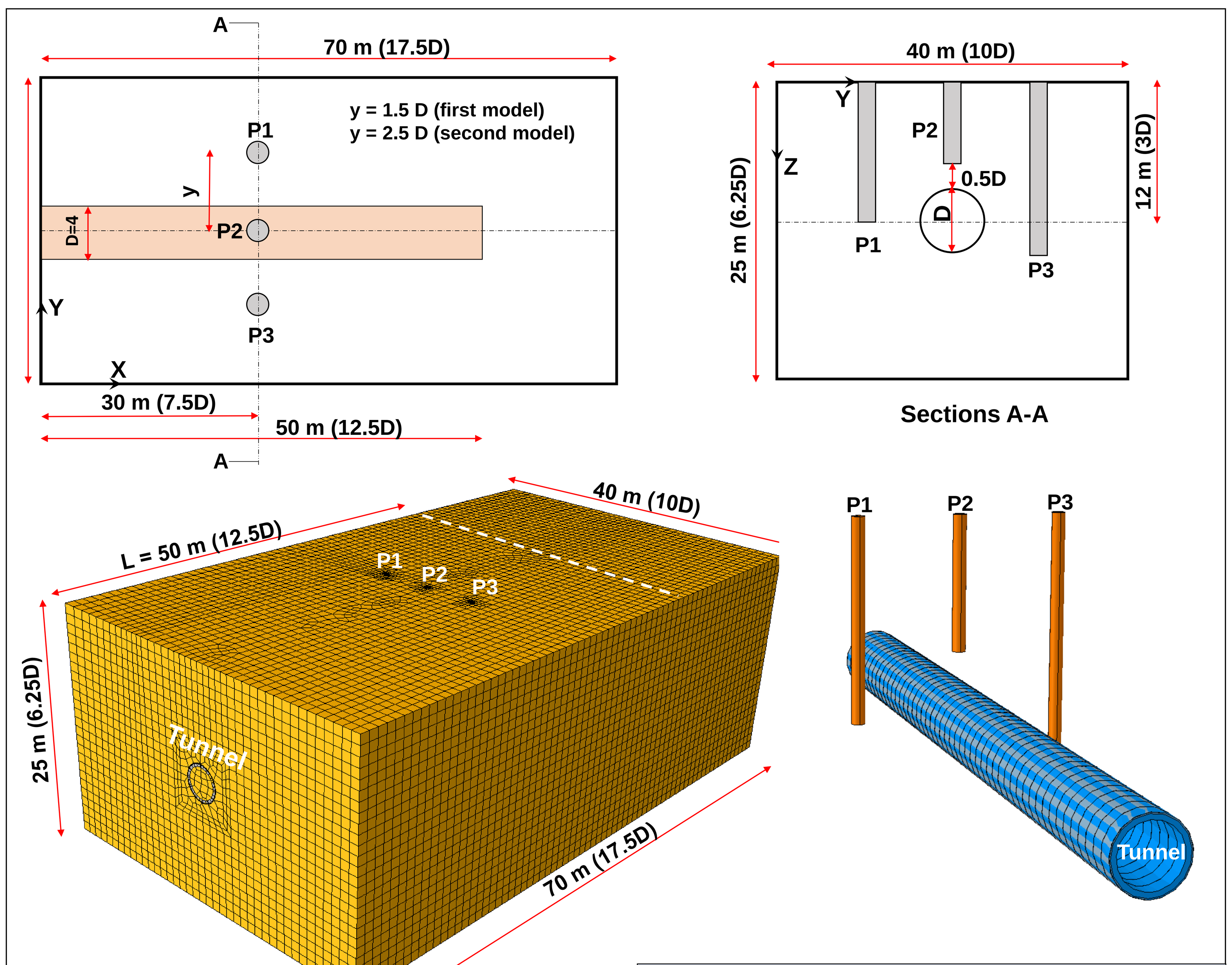
3-D conceptual drawing showing each piece of the mini-TBM



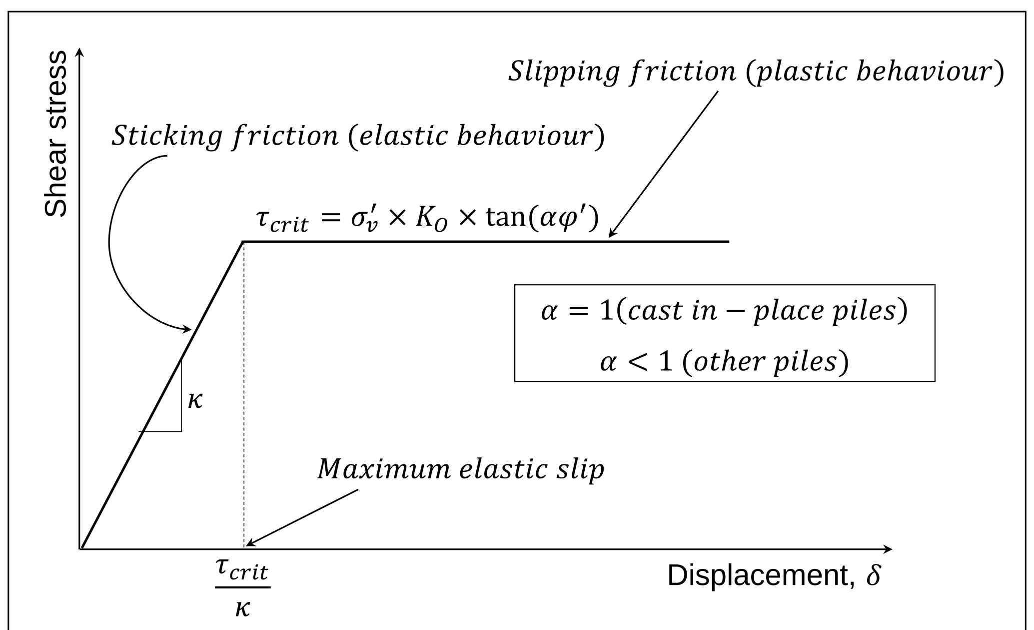
2b. Methods - numerical modelling



step-by-step numerical procedure

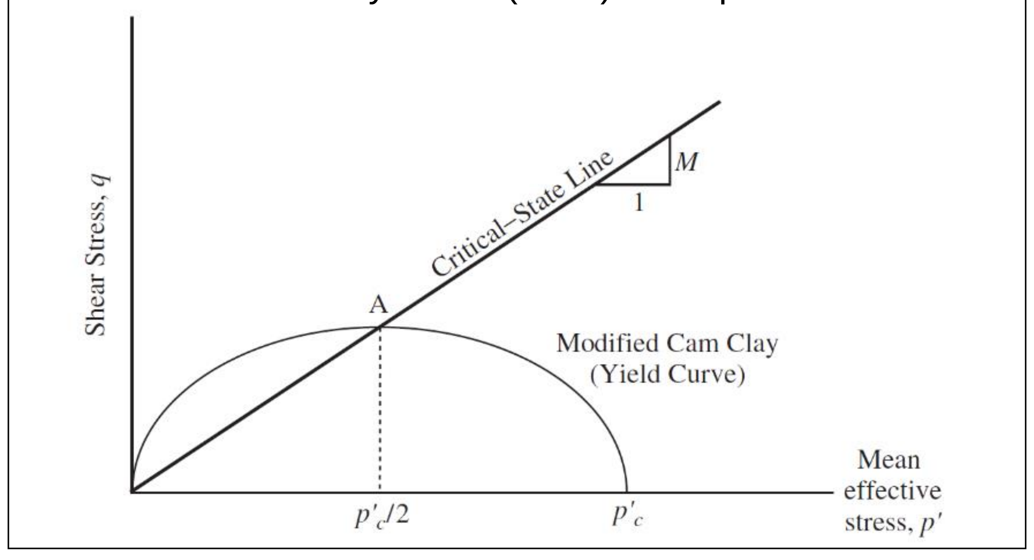


layout of the numerical model

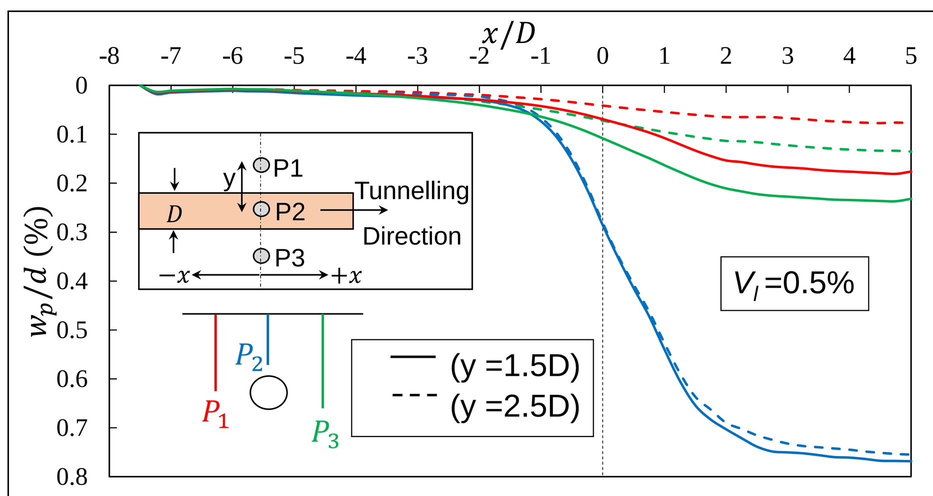


Details of the soil-pile interface

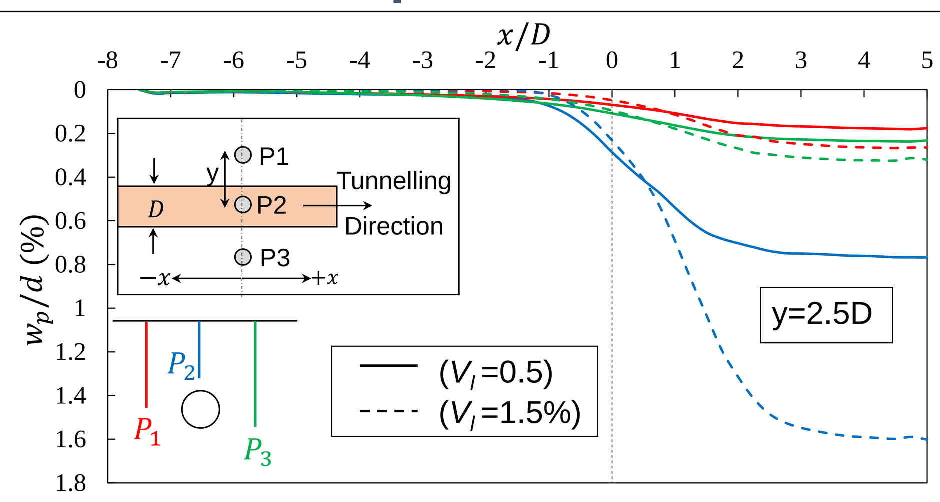
normally consolidated kaolin clay is used in the analyses and the Modified Cam Clay model (MCC) is adopted

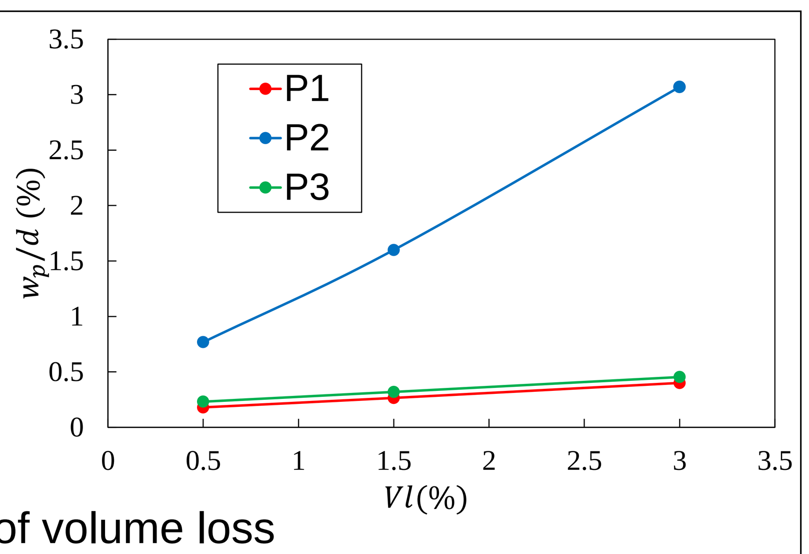


3. Selected Results – Vertical displacements



Influence of distance from the tunnel axis





Influence of volume loss

4. Progress and future work

- The mini-TBM was successfully tested on the lab floor and is now ready to be tested in the centrifuge.
- Numerical procedures are now fully defined, a full parametric study will be run.