Branschsamverkan i Grunden

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Branschsamverkan I Grunden

Re-use of pile foundations (RiPofF). Long term benefits for axially loaded pile foundations.

Jorge Yannie

Jelke Dijkstra

Objectives

- Study the evolution of the soil strength and stiffness adjacent to a pile in natural soft clay.

- The evolution time covers the complete pile cycle, i.e. from installation to pile set-up and long-term loading.

Organisation

- *Interpretation of physical models, e.g. centrifuge pile installation.*
- *Pile-soil interface element tests.*
- *Implementation of simplified analytical pile installation models.*
- *Numerical modelling incorporating rate-dependency and time effects.*

Pile installation

- Complex kinematic process.
- Large soil distortions.
- Changes in soil properties and stress field.

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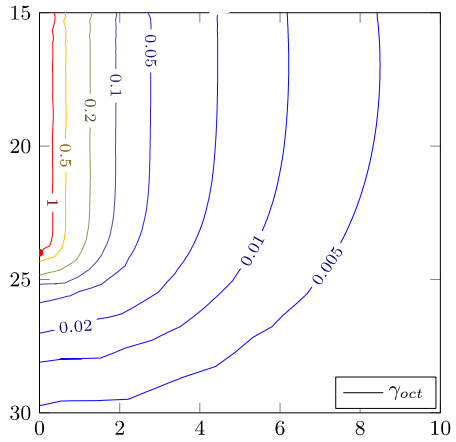
How to measure the installation effects?

- Physical models, e.g. centrifuge.
- Fully instrumented field tests.
- Numerical models, e.g. Strain Path Method, large strain finite element (ALE).

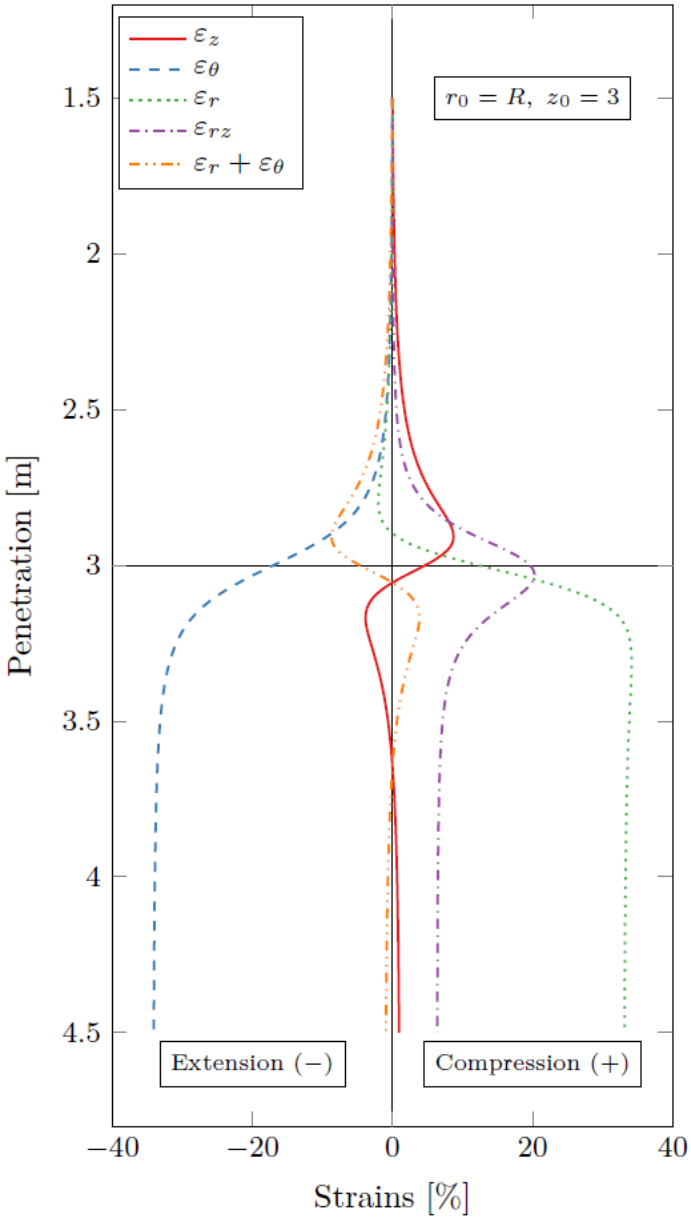
Numerical model: Strain Path Method (SPM)

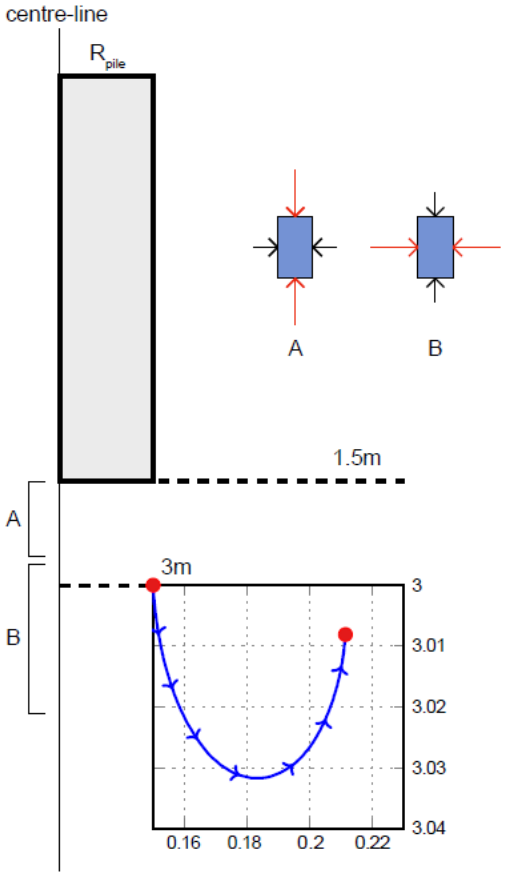
- Pure kinematic model independent of soil properties.
- Quasi-static steady state penetration, based on Potential Flow Theory (combination of source and sink in an uniform fluid flow).
- The resulting strain paths are used in combination with any effective stress soil model.

SPM



Octahedral deviatoric strains plotted in relation to the initial not deformed mesh.

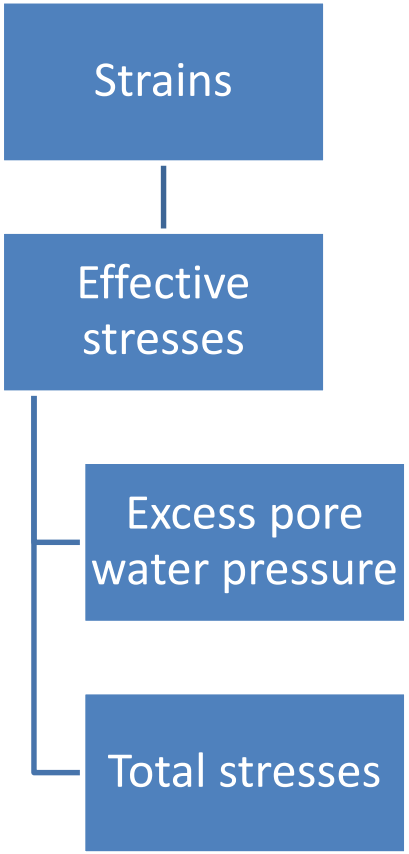




Effective stress soil model

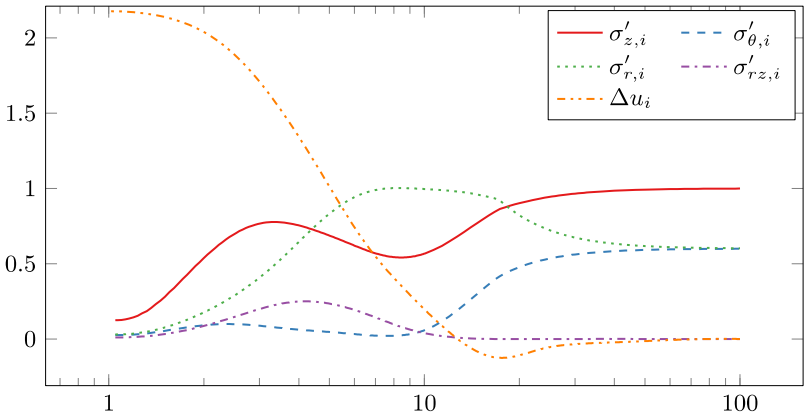
SCLAY1-S

- Elastoplastic soft soil model for normally to slightly overconsolidated clays.
  - Anisotropy
  - Structure

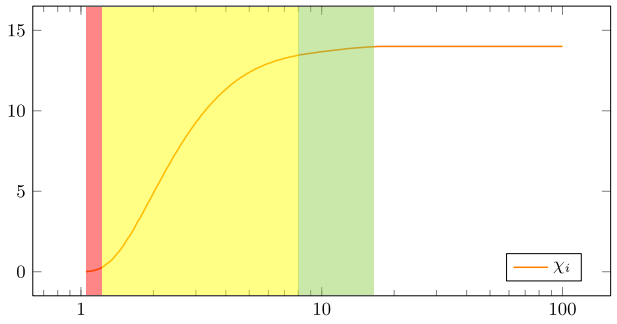


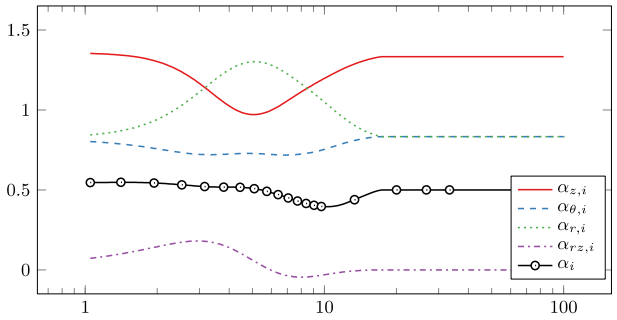
SPM + SCLAY1-S

- Stresses



- State variables





Pile set-up

- The stresses, excess pore water pressures and soil model state variables are passed on to the CREEP-SCLAY1S.

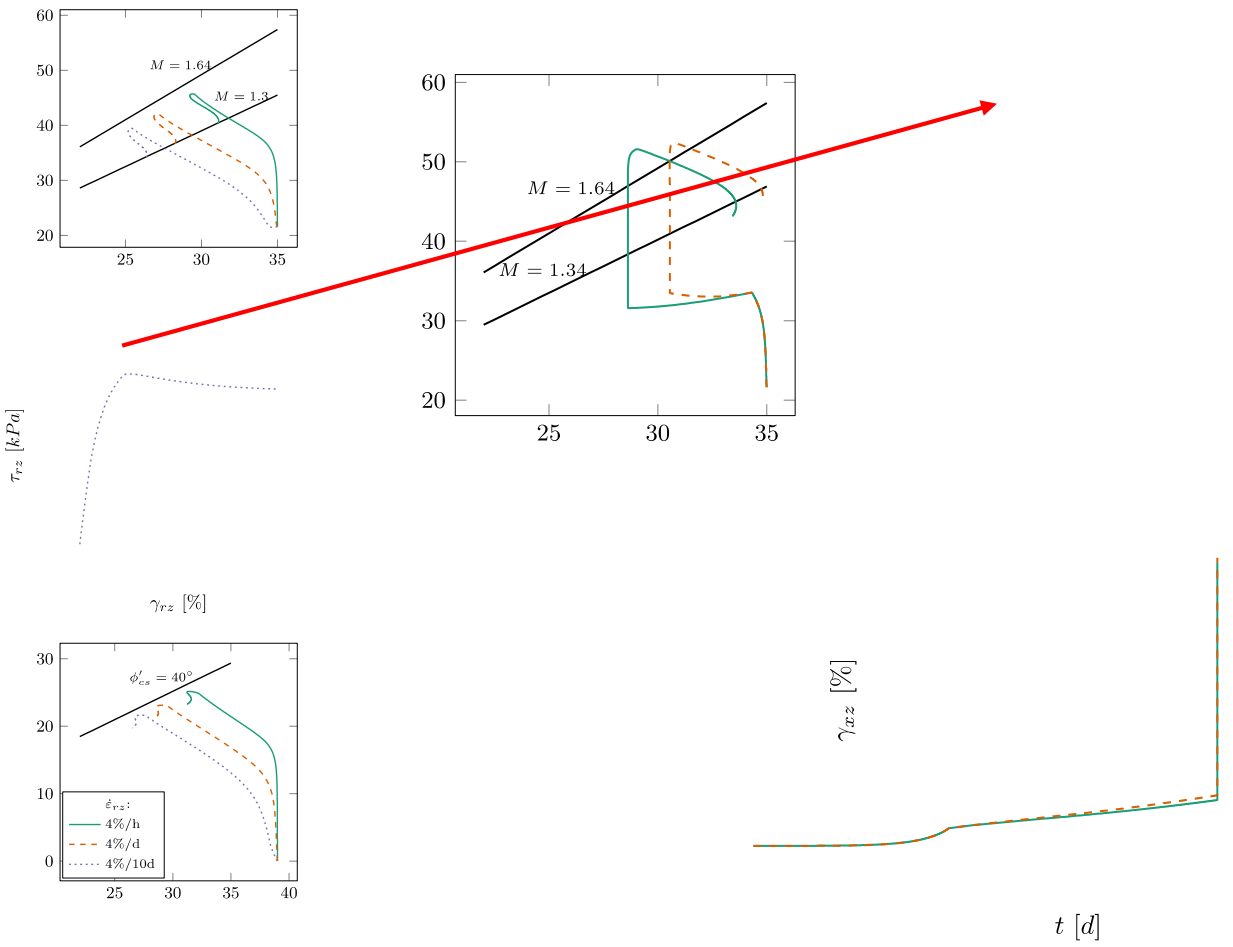
- 1D radial consolidation of installation pore water pressures.

Pile loading

- Simulate element tests at different radial locations from the pile shaft. Use of different boundary conditions, e.g. DSS analogy. Use:
  - Virgin loaded piles
  - Long-term loaded piles

- Model full boundary value problem in homogeneous soil deposit.

Pile loading – long-term loaded piles



Conclusions

- All stages in the pile cycle are very important for prediction the long-term response.
- A rate-dependent (time) model is required in order to study the evolution of strength and stiffness.
- Determining the right boundary conditions next to the pile shaft is necessary to properly estimate the changes in stresses with time.

Recommendations

- Additional feature as thixotropy and small strain stiffness should provide a better estimate of the long-term response.

- Investigate the full strain and stress fields adjacent to the pile during and after pile installation.