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A new design tool for retaining walls

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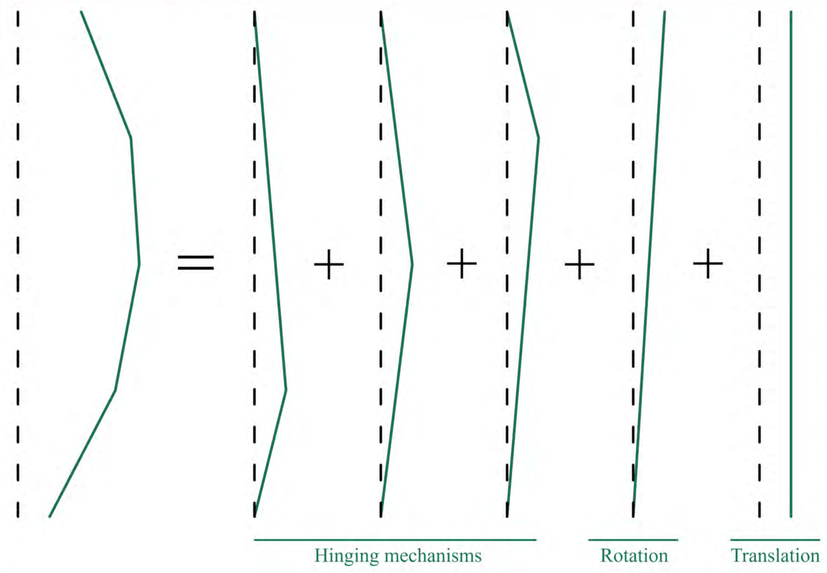
Geotechnical area: design, excavations, retaining walls

Motivation

Conventional design of retaining walls is based on plasticity theory for safety calculation but elasticity theory for serviceability calculation. Finite element and finite difference methods can overcome such an inconsistency, with relatively complex soil constitutive models, however, causing computational overhead during analysis.

There is hence a requirement for ***an efficient tool*** considering safety and serviceability simultaneously and converging rapidly, which could be used by ***practising engineers*** to ***rapidly assess*** the performance of different wall geometries and construction sequences at early stages of the design process.

Methodology

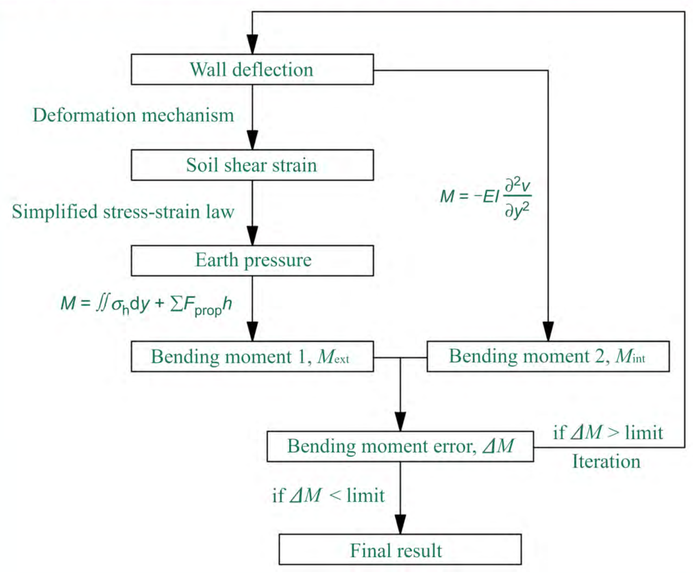


Any ***flexible wall deflection*** can be superposed by a series of hinging mechanisms, rigid wall rotation about the base and translation (Haigh, 2013).

Soil deformations in front of and behind the flexible wall can also be superposed by the corresponding basic deformation mechanisms (Diakoumi & Powrie, 2013), with ***earth pressures*** being subsequently calculated using a simplified stress-strain law.

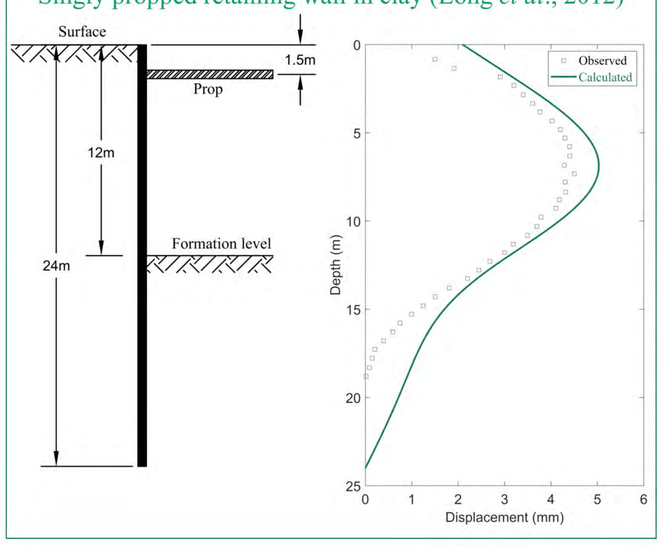
Iteration of two bending moments, M_{ext} being integrated from ***earth pressures*** and M_{int} being differentiated from the ***wall deflection***, allows equilibrium to be achieved with final results being worked out (Deng *et al*., 2021).

Implementation in MATLAB



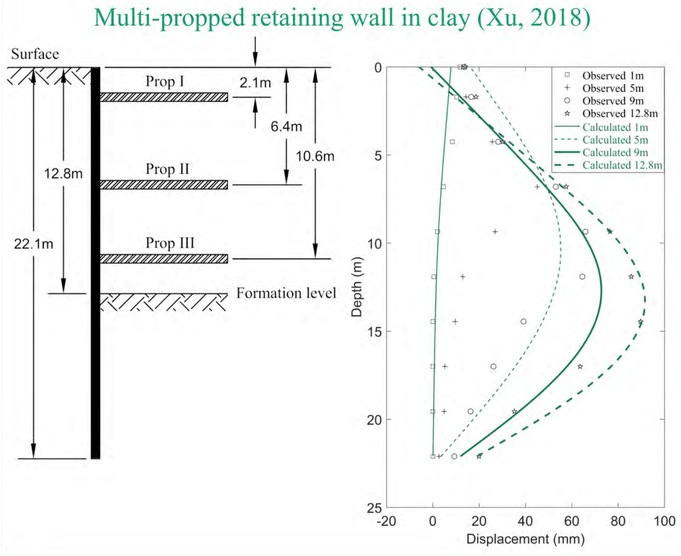
Validation I

Singly propped retaining wall in clay (Long *et al*., 2012)



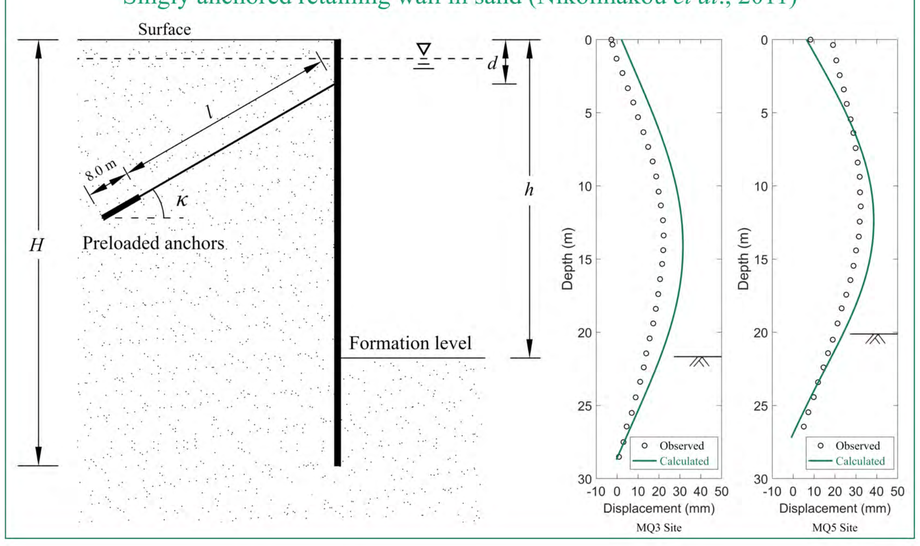
Validation II

Multi-propped retaining wall in clay (Xu, 2018)



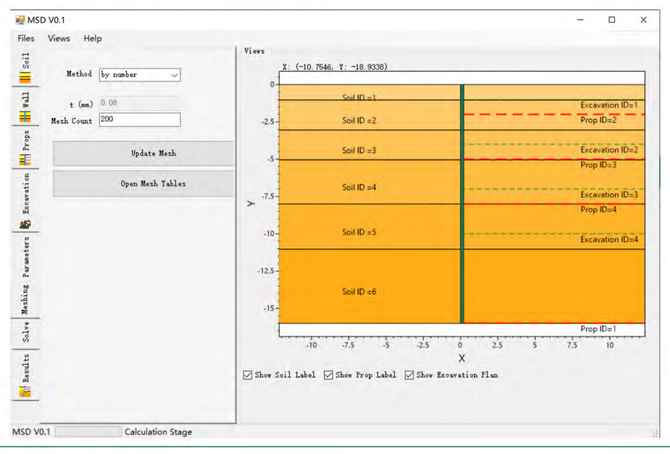
Validation III

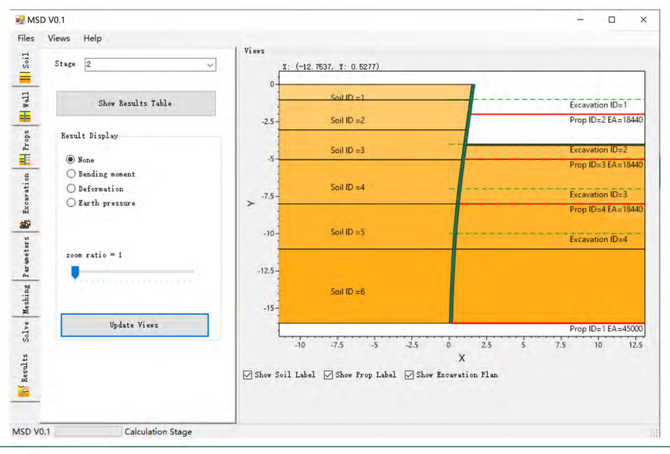
Singly anchored retaining wall in sand (Nikolinakou *et al*., 2011)

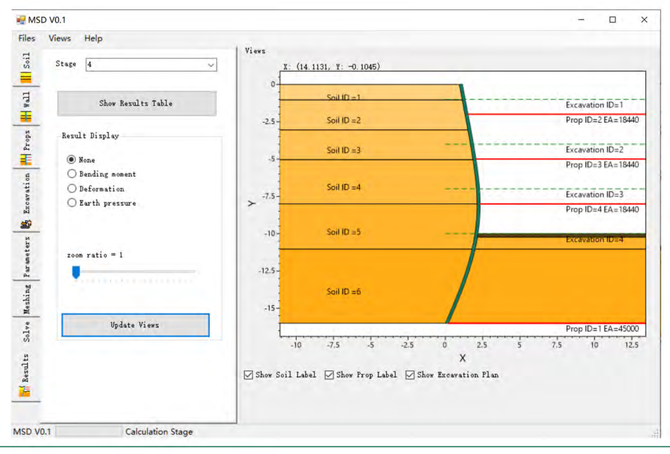


Software developed in C#

The software MSD, based on the method presented above and developed in C#, is able to analyse cantilever and propped walls and potential lack of fit or over-fitting of props. This software works extremely efficiently as setting up a model only requires input of geometry, strength and stiffness parameters and each stage of excavation (with 500 mesh nodes in the wall) converges in around 15 s.







Conclusions and Discussion

- A new design method based on rigid wall results has been successfully proposed for flexible walls, with safety and serviceability being considered simultaneously.
- The software MSD allows an effective analysis for retaining wall behaviour with simple operation and rapid convergence.
- The current version of the software has worked out wall behaviour, with the calculation for soil behaviour (e.g. surface settlement) being developed in the future work.

References

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