Hypoplastic modeling of soil-structure interfaces in offshore applications

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MOTIVATION

The soil-structure interface behavior of cyclic and monotonic loaded offshore structures (e.g., piles, anchors, and pipelines) is important for the life-cycle and design of such structures.

Especially the cyclic modeling of interfaces and the influence of using more advanced interface models when dealing with sensitive marine clays is important to get realistic results.

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METHOD & HYPOPLASTIC MODELS

The numerical implementation scheme from Stutz et al. 2017 was used to implement the constitutive models in their reduced form as interface soil-structure models.

The hypoplastic model by Von Wolffersdorff (1996) and the hypoplastic fine-grained (Mašín 2014) models with their intergranular strain extension (Niemunis & Herle 1997) was used.

The constitutive equation can be written in the following form:

$$\dot{\boldsymbol{T}} = M : \dot{\boldsymbol{D}}$$

Where, M is a fourth-order tangent stiffness material tensor, $\dot{\boldsymbol{T}}$ is the stress rate tensor, and $\dot{\boldsymbol{D}}$ is the strain rate tensor.

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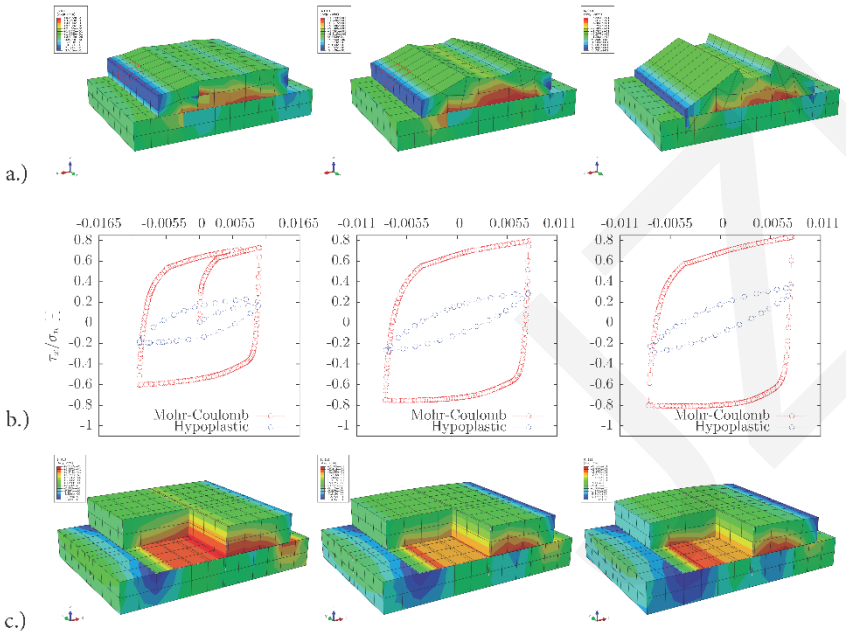
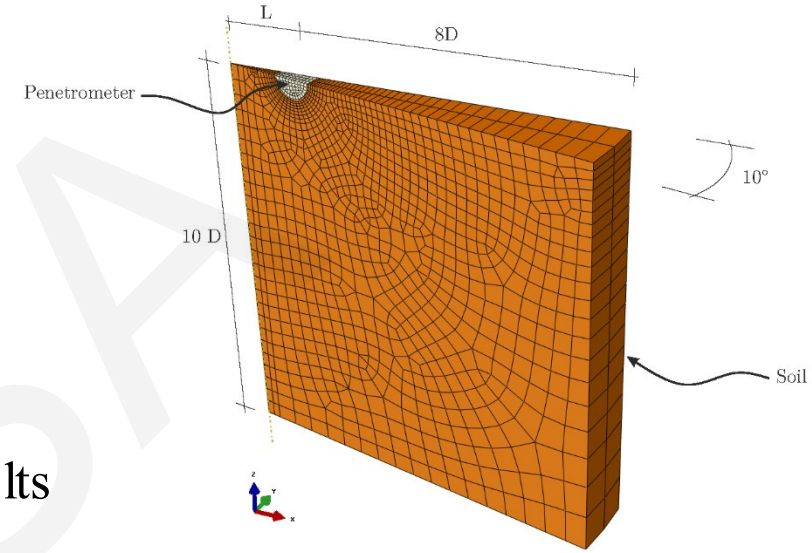
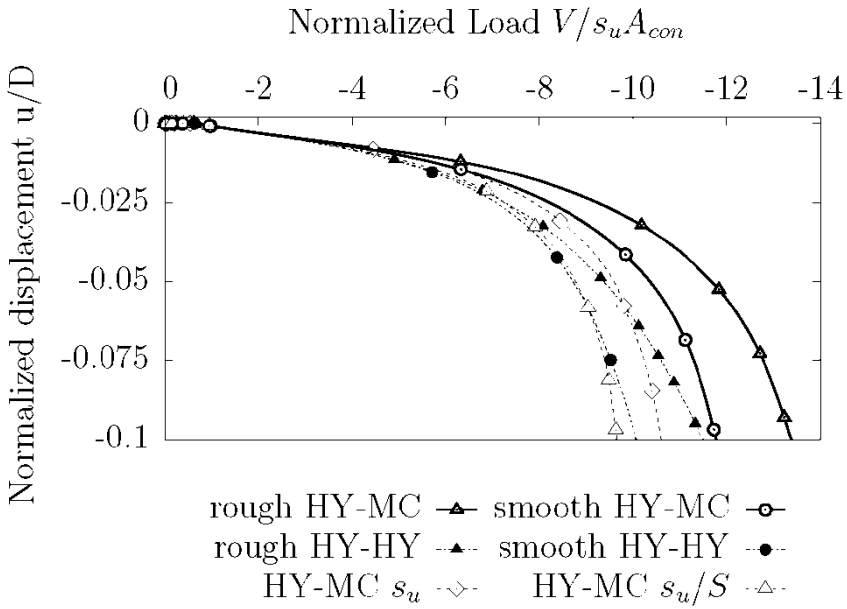
SIMULATION RESULTS

Direct shear simulations with cyclic loading show a clear enhancement by employing a hypoplastic model.

In the penetrometer simulation it is observed that holistic coupling of models lead to more realistic and better results







CONCULSIONS

- The inter-granular strain concept can be used for the modeling of interfaces
- The reduced stress and strain tensor concept can be used in conjunction with the numerical implementation scheme (Stutz et al., 2017).
- The benefit of using the concept of degradation of existing concepts for modeling the 3D soil continuum to interface models is the opportunity to easily adapt constitutive models and the lack of specialized parameter calibration considering a fully calibrated constitutive model used to model the surrounding soil.

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