A cleaning model for film-like soils with transition between cleaning mechanisms

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Problem & Strategy

Starting point

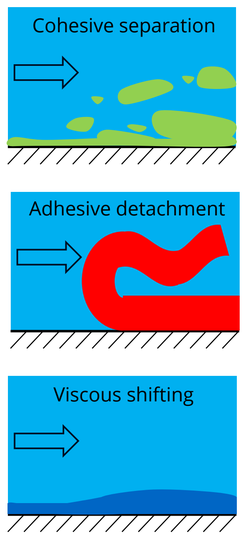
- Film-like soils classified by cleaning mechanism
- Approach: Decouple fluid and soil computation
- Validated models for each mechanism available
- Models for water as cleaning fluid at $\vartheta = \text{const.}$

Target and problems addressed

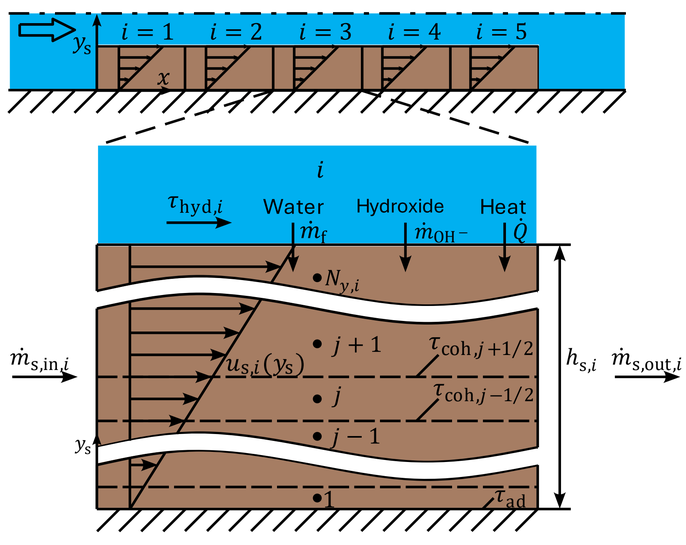
- Realistic soils
- CIP-procedures
- Variation of temperature
- Variation of cleaning fluid

} Transition between cleaning mechanisms

Cleaning mechanisms

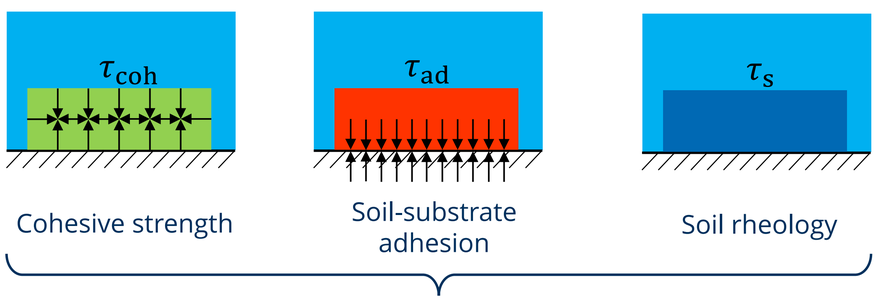


Combined cleaning model



1 Required material parameters

Soil properties relevant for each cleaning mechanism:

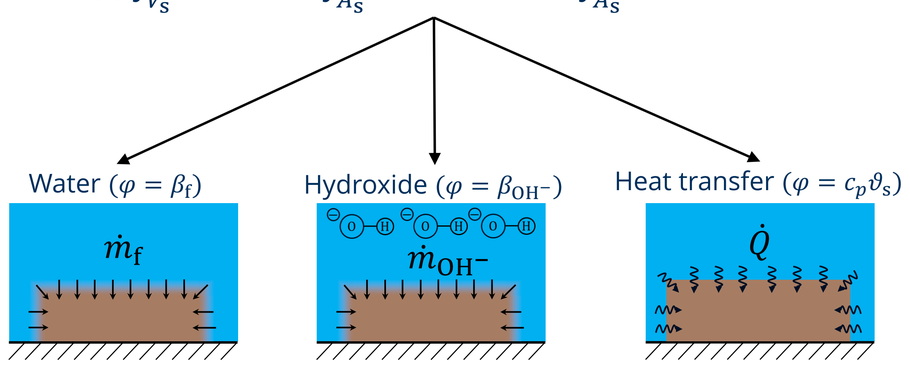


Depend on water concentration $\boldsymbol{\beta_f}$, hydroxide concentration $\boldsymbol{\beta_{OH^-}}$ and temperature $\boldsymbol{\vartheta}$.

2 Modeling of transport processes

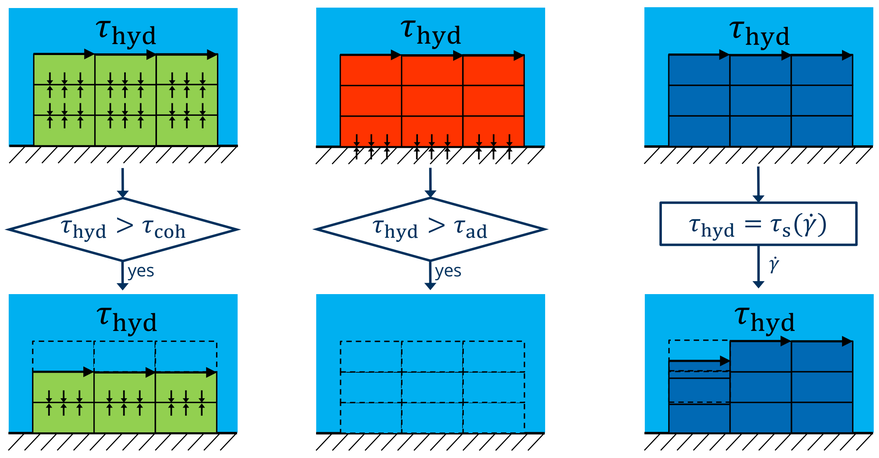
Distribution of quantities in soil described by transport equation:

$$\frac{\mathrm{d}}{\mathrm{d}t}\int_{V_s}\varphi\,\mathrm{d}V = -\int_{A_s}\underline{J}_{conv}\cdot\underline{n}\,\mathrm{d}A - \int_{A_s}\underline{J}_{diff}\cdot\underline{n}\,\mathrm{d}A$$



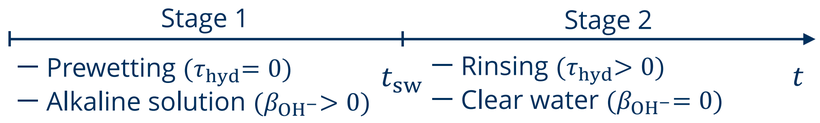
3 Removal criteria

Compare hydrodynamic load τ_{hyd} from fluid flow with soil property:

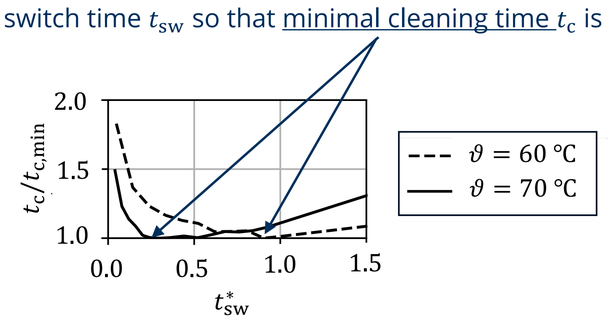


4 Application: Soil in heat exchanger

Optimization study: Cleaning of a proteinaceous soil in a heat exchanger



Goal: Select switch time t_{sw} so that minimal cleaning time t_c is obtained



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