Investigations on the Influence of Suction Dredging on the Failure Mechanism of Subaqueous Slopes with Coupled CFD-DEM

Manuela Kanitz*, Jürgen Grabe*, Alice Hager† and Christoph Goniva†

* TUHH Institute for Geotechnical Enginnering and Construction Management
21079 Hamburg, Germany
e-mail: manuela.kanitz@tuhh.de, web page: http://www.tuhh.de/gbt

† DCS Computing GmbH,
4020 Linz, Austria
e-mail: alice.hager@dcs-computing.com, web page: http://www.dcs-computing.org

ABSTRACT

In order to investigate the triggered failure mechanism and the remaining slope angle, a coupled Euler-Lagrange approach, namely the combination of Computational Fluid Dynamics (CFD) and the Discrete Element Method (DEM), is used. In these simulations, the liquid phase, e.g. the water, is considered as a continuum and the solid phase, e.g. the soil, is represented with particles. Hence, it is possible to compute the particle-particle- as well as the fluid-particle-interactions. The calculations are carried out with the open source software package CFDEM®coupling, which combines the discrete element code LIGGGHTS® with CFD solvers based on OpenFOAM®.

In order to investigate the triggered failure mechanism and the remaining slope angle, a coupled Euler-Lagrange approach, namely the combination of Computational Fluid Dynamics (CFD) and the Discrete Element Method (DEM), is used. In these simulations, the liquid phase, e.g. the water, is considered as a continuum and the solid phase, e.g. the soil, is represented with particles. Hence, it is possible to compute the particle-particle- as well as the fluid-particle-interactions. The calculations are carried out with the open source software package CFDEM®coupling, which combines the discrete element code LIGGGHTS® with CFD solvers based on OpenFOAM®.

In the numerical simulations on suction dredging, a coarse-grained and uniform graded sand will be investigated, whereas the soil grains are idealized by spherical particles of different diameters. In order to consider effects of dilatancy and contractancy in the soil bed, different relative densities are investigated. The influence of dilatancy and contractancy is a crucial point for the investigation of a subaqueous slope. Shear loading leads to periodical changes between dilatant and contractant behavior of the soil bed. The changes in the pore water pressure due to the change of pore volume results in local hardening and loosening of the soil bed, which influences significantly the slope stability. The implemented force models are used to consider the effect of the fluid on the particles and vice versa. Due to the high number of particles in the model, unresolved CFD-DEM is chosen, where the particles are significantly smaller than the CFD cells. As the fluid flow through the particle bed is averaged, a lubrication force model is used to consider the effect of particle collisions in a fluid.