Masterarbeit / Master Thesis

Thema:

Numerical Simulation of the LEAP-2017 Experiments using Hypoplasticity

Beschreibung/Motivation:

During strong shaking (e.g. during an earthquake) fully saturated soils experience an increase in pore water pressure. If the increase is so large that the effective stresses approach zero and the soil is said to have liquefied. The loss of effective stress means the soil is not capable of sustaining any shear stresses leading in some cases to catastrophic failures.

As part of an international research project, LEAP-UCD-2017, the repeatability, variability, and sensitivity of centrifuge tests in modelling lateral spreading of mildly sloping liquefiable soils were investigated. To achieve this goal, 24 centrifuge tests were conducted at 9 different centrifuge facilities around the world. The results of these centrifuge tests allowed for defining a response surface and enabled an assessment of the sensitivity and variability of the tests. For the first time, a sufficient number of experiments were conducted on the same test configuration to enable the assessment of the test-to-test and facility-facility variability of the centrifuge test results.

These experiments, of which the model set-up is depicted in Fig. 1, can be used for the validation and further development of new soil constitutive models, capable of describing realistically the mechanical behaviour of soils under cyclic loading. However, the process of calibrating material parameters from laboratory tests in geotechnical engineering for the use in numerical simulations (e.g. serviceability and ultimate limit state analyses) can often be very subjective. In order to improve not only the efficiency of the calibration process and to establish an objective framework for the selection of the 'best-fit' parameters including upper and lower bounds of the expected behaviour of the soil an optimization tool based on the Genetic Algorithm has been developed in Python and applied to calibrate the material parameters for the the constitutive model Hypoplasticity (VON WOLFFERSDORFF , 1996) for various types of soils.

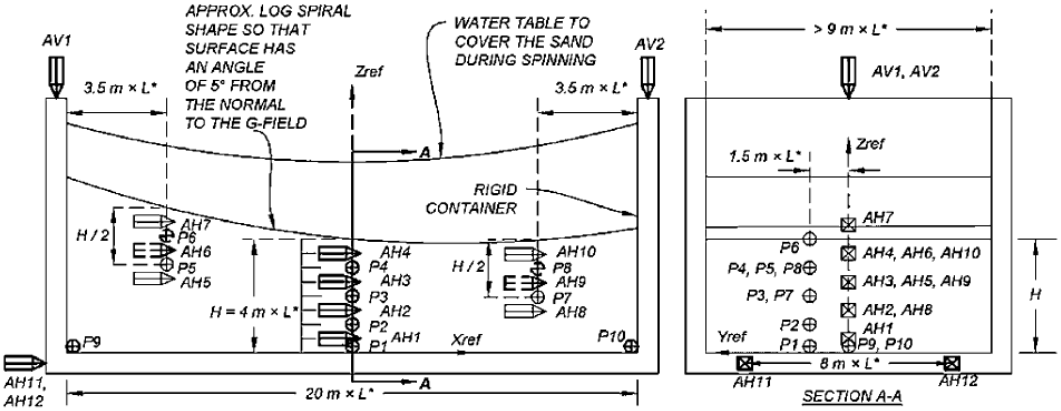

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Figure 1: Centrifuge Model Test

Aufgabenstellung:

The scope of this work is the simulation of the centrifuge experiments of the LEAP-2017 project using an advanced hypoplastic law (VON WOLFFERSDORFF , 1996 or GRANDAS TAVERA et. al., 2019). In order to take into account the hydro-mechanical coupling during the dynamic loading, an already implemented User Element (UEL) for the u-p formulation (Zienkiewicz et.al.,1999) will be used.

The following steps shall be undertaken during the completion of the master thesis:

- Acquisition of the LEAP-2017 experimental data.
- Calibration of an advanced hypoplastic consitutive law based on the laboratory data. For the calibration an in-house developed program based on geneticalgorithms shall be used.
- Simulation and interpretation of the centrifuge experiments using the best fit parameters.
- Undertaking of a sensitivity analysis to determine the influence of material parameters and the soil permeability on the response (e.g. deformation, peak ground acceleration PGA, response spectra) shall be conducted. For the numerical analysis the initial state variables (e.g. void ratio, permeability) and constitutive model parameters shall be defined stochastic based on the experimentally observed variability.

Spezielle Anforderungen an den Bearbeiter:

- Good knowledge of soil mechanics.
- Interest in the numerical simulation of geotechnical problems relating to soil liquefaction with FE method and advanced constitutive model.
- Basic understanding of Geostatistics

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Ausgegeben an:

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Literatur:

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