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Implementing Variations on Geotechnical Measurements into FEM Soil Material Parameters

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Extended Abstract

In Finite Element Model (FEM) software the mechanical behaviour of soils is modelled with (advanced) soil material models (e.g. Hardening Soil) involving multiple input parameters. Advanced models are chosen to implement specific features, such as strain-hardening and stress-dependency of stiffness. Determination (and calibration) of these model parameters requires a set of different advanced laboratory tests. In many projects however, this full set of advanced laboratory tests is not available. Therefore, as alternative, correlations between model parameters and other test data can be used.

Obtaining a set of compatible material model parameters is a time consuming and iterative process. Therefore, in most projects only one set of design parameters is determined (e.g. based on measurements low, best or high estimates). Often the approximation of independent parameters is applied, however in reality they are linked to each other. As a result variations in measured data are not taken into account and a range or variation around the expected output of FEM calculations cannot be provided (although these variations do exist). A methodology was developed to provide a realistic, data-driven range on the FEM calculated settlements of an sediment placement site in the North Sea. The methodology allows for fast processing and is applicable on other soil material model based calculations.

Generating data-driven variations demands for fast processing of a big set of measured datapoints. In order to overcome this problem three groups of scripts have been developed in this study. Furthermore, a visual programming work flow has been developed to ensure a correct execution order of each script. The first group establishes uniformization over all datasets. The script sorts data and provides structure, needed for correct conversion of one (or more) measured data points to model parameters. The second group provides formulations to correlate or convert the measured datapoint into a datapoint prediction of a model parameter. Conversions from (detailed) lab test data are directly based on the theoretical formulations of the advanced material model. In-situ measured (e.g. CPT) data are converted based on existing correlations from literature. The third group allows to statistically fit an appropriate distribution on one (or more) predicted model parameter(s) and to merge distributions generated from different data sources (in-situ vs. lab data).

During the execution of the scripts (with the visual work flow), the geotechnical experts should cross validate the performance of different correlations to nearby lab test results and select the appropriate correlations. Experts should then validate which distribution is appropriate for each model parameter and assign weighting factors to merge distributions of different data sources. The fitted distributions of all model parameters are developed while including the parameter dependencies as dictated by the theoretical formulations of the material models. From these merged distributions, precise (percentile based) selections will result in a FEM applicable set of material model input parameters. Running multiple sets in FEM calculations will then result in a data-driven variation around the preferred output.

The presented methodology, with visual work flow and scripts, can be easily adapted to other projects with different data sources or different soil material models.

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