Parameter estimation for hypoplastic models

Aim of the research project

Cohesionless soils show a complex stress-strain behavior that depends on the stress and strain state, the initial density and also on the stress history among other things. Many constitutive models are capable to model some of these aspects and few models are able to take all this into account. The hypoplastic model developed by von Wolffersdorf (1996) is able to model all this aspects in a satisfactory manner for problems with monotonous loading and most important, all of this with one set of parameters. Unfortunately, a correct parameter estimation for this constitutive model represents a great challenge that discourages new and inexperienced users. The use of an inverse analysis to estimate the hypoplastic parameters can overcome most of the difficulties encountered by forward or “classical” parameter estimation. Therefore, efforts have been directed towards the implementation of such technique for the hypoplastic model in question. The main objective of this implementation is to make the parameter estimation for the hypoplastic model a more accessible procedure.

Approach and results

The first step consisted in assessing the applicability of the parameter estimation via inverse analysis to this hypoplastic model. Therefore, synthetic data was used as reference data for the inverse analysis. This allowed not only a pure evaluation of the inverse analysis (without external factors or uncertainties) but also an identification the required experimental data for a proper parameter estimation.

As second step, the information obtained was applied to design an experimental program. This required the design and construction of a new device that will allow the attainment of the required experimental data. Then the implementation was successfully tested using real soil data. An optimal set of parameters was obtained for the Aachener sand.

As a third and last step, the newly obtained parameters were validated by calculating different laboratory tests using FEA. These tests were selected in such a way that both, the sample preparation as well as the boundary conditions differ with the ones used for the parameter estimation. The simulations showed a remarkably good agreement with the laboratory results.

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