Modelling of soil behaviour with hypoplasticity: another approach to soil constitutive modelling

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Abstrak

This book explains the hypoplastic modelling framework. It is divided into two parts, the first of which is devoted to principles of hypoplasticity. First, the basic features of soils mechanical behaviour are introduced, namely non-linearity and asymptotic properties. These features are then incorporated into simple one-dimensional hypoplastic equations for compression and shear. Subsequently, a hypoplastic equivalent of the Modified Cam-Clay model is developed in 2D space using stress and strain invariants to demonstrate key similarities and differences between elasto-plastic and hypoplastic formulations. Lastly, the mathematical structure of hypoplastic models is explained by tracing their historical development, from the early trial-and-error models to more recent approaches. In turn, Part II introduces specific hypoplastic models for soils. First, two reference models for sand and clay are defined. After summarising their mathematical formulations, calibration procedures are described and discussed. Subsequently, more advanced modelling approaches are covered: the intergranular strain concept incorporating the effects of small strain stiffness and cyclic loading, viscohypoplasticity for predicting rate effects, soil structure to represent structured and bonded materials and soil anisotropy. The book concludes with a description of partial saturation and thermal effects: topics that are increasingly important to the disciplines of energy and environmental geotechnics.

Selecting a constitutive model and its parameters is often the most important and yet challenging part of any numerical analysis in geotechnical engineering. Hypoplasticity involves a specific class of soil constitutive models, which are described in detail here. The book offers an essential resource, both for model users who need a more advanced model for their geotechnical calculations and are mainly interested in parameter calibration procedures, and for model developers who are seeking a comprehensive understanding of the mathematical structure of hypoplasticity.