A Concept for Modelling of Coarse-grained and Weathered Granular Materials

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Abstract

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To predict the mechanical properties of coarse grained and weathered materials like soils, rockfills and MBT wastes a large number of various constitutive models based on continuum theories are proposed in the literature. In this paper the framework of hypoplasticity introduced by Kolymbas is considered, which allows the modelling of a non-linear and inelastic material behavior without any decomposition of the deformation into elastic and plastic parts. A benefit of this framework is the rather easy adaptation of the material parameters to experimental data. Based on the general concept of hypoplasticity different versions of hypoplastic models for particular granular material properties have been developed. The present paper will give an overview and will show how the concept of the critical state soil mechanics can be included into hypoplasticity and how the influence of pressure, density, creep and stress relaxation of unweathered, weathered and moisture sensitive granular materials can be taken into account. In this context the so-called "solid hardness" is a key parameter for describing the influence of the state of weathering on the incremental stiffness. In particular, the solid hardness is defined as the stress under monotonic isotropic compression, where the compression curve in a semi-logarithmic representation shows the point of inflection. Experimental investigations show that the value of the solid hardness is well defined and rather independent of the initial packing density of the grains. In order to model the time dependent process of the degradation of the granular hardness an evolution equation is proposed which takes into account creep and stress relaxation in a consistent manner.
The applicability and performance of particular versions of hypoplastic models will also be demonstrated for different case studies by comparing the numerical simulations with laboratory data and field measurements.

Keywords: Hypoplasticity, CSSM, Solid Hardness, Creep, Stress Relaxation.