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RECENT PROGRESS ON A SUCTION DEPENDENT CAP MODEL FOR SOILS

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This contribution is on a multiphysics (i.e. multi-phase) modelling approach for soils, i.e. a special class of geomaterials. In general, porous geomaterials are characterised by a certain degree of permeability, allowing liquid and gaseous phases to enter and flow through the pore space in a structure matrix. The interaction between pore filling fluids and surrounding structure has a strong influence on the mechanical response of a geomaterial. Thus, for a numerical modelling approach, these interactions have to be taken into account.

The focus of the talk will be on the constitutive model relating strain and two independent stress variables, in our case generalised effective stress and matric suction. It is designed for applications in coupled three-phase simulations, see for instance [1] for an overview on the surrounding framework. The elasto-plastic cap model presented here is a recent enhancement of a model which has been under constant development over several decades. Its origins date back to the well known multi-surface plasticity model [2]. More recently, the model was extended to partially saturated soils in [3]. This extended version already took into account a suction dependence of the yield surface via a load-collapse yield curve, as it is also done for instance in the Barcelona Basic Model [4]. In parallel, another enhancement was introduced in [5], by proposing smooth transitions between the different loading surfaces, thus simplifying stress projection and avoiding singularities in tangents. This idea was included in the model [3] in [6], where a smoothing was applied not only for values of constant matric suction but was also introduced for the transition from partially to fully saturated state. As described in [7], the volumetric elastic material response of the cap model for partially saturated soils was also improved such that it is now able to provide a more realistic, exponentially stiffening response.

The version of the model proposed in the present contribution even further improves the above mentioned developments by including a number of additional features. Firstly, plastic dilation is now associated with a softening material behaviour, a relation also present for instance in the Barcelona Basic Model. This new feature limits plastic swelling of the material, which could occur under certain loading conditions, to a physically reasonable amount. Furthermore, for the new version, the smoothing of the surface does not affect the cohesion parameter anymore. Thus, it is now more straight forward to use values available in literature. Finally, the volumetric elastic law was improved such that it is now able to account for states of zero pressure, a capability which was not present in the exponentially stiffening response proposed earlier.

The new features simplify the model, facilitate the setting of parameters, and extend the range of applicability whilst the helpful smoothness properties introduced previously are preserved. To show the new capabilities of the method, results will be shown both for benchmark test cases (at the material point level, using experimental data from [8]) as well as for coupled finite element simulations.

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