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NUMERICAL IMPLEMENTATION OF A PLASTICITY MODEL WITH GENERALIZED HARDENING FOR CALCARENITE ROCKS

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Abstract. An extended theory of plasticity with generalized hardening has been recently presented in [1] to describe the response of natural calcarenite rocks under both mechanical and environmental degradation processes. In this theory it is assumed that the coupling between mechanical and environmental processes takes place at two levels: a) as an additional direct contribution to the constitutive stress changes, taking place even for purely elastic processes; and, b) as a consequence of the evolution of the internal state variables of the material with the changes in the environmental process variables.

As such, the theory incorporates as special cases: a) the elastoplastic models for unsaturated soil where *suction hardening* is assumed to reproduce the phenomenon of collapse upon wetting in unsaturated soils [2, 3]; b) the thermoplastic models for rocks [4] and soils [5, 6, 7], in which the internal variables depend on the temperature T (*thermal softening*); c) the extension of classical elastoplasticity advocated in [8, 9, 10] to describe *chemical degradation effects* in cemented granular soils or weak rocks.

The aim of this work is to present in detail an implicit integration strategy – based on the modification of the classical predictor–corrector return mapping algorithm discussed in [9] – for the FE implementation of a specific constitutive model for unsaturated calcarenite rocks subject to weathering processes. For this particular class of geomaterials, the degradation effects induced by weathering are due to: a) changes in degree of saturation (*short–term debonding*); b) chemical dissolution of the bond material (*long–term debonding*), and c) *grain dissolution*) effects.

Representative numerical simulations are performed to demonstrate the capabilities of

the model and to show the impact of environmental loads in realistic initial/boundary value problems.

The result obtained demonstrate the practical applicability of the proposed theory and highlight the relevance of environmental degradation effects in engineering applications, as in several circumstances such effects may take place over periods of time comparable with the life cycle of common geotechnical structures.

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