Isogeometric FE implementation of a second–gradient plasticity model for coupled hydro–mechanical problems

Carlos Plúa*, Claudio Tamagnini† and Pierre Besuelle*

*Laboratoire 3SR
Université Grenoble Alpes, INP, CNRS
Domaine Universitaire BP 53, 38041 Grenoble, France
e-mail: carlos.plua.g@gmail.com, pierre.besuelle@3sr-grenoble.fr

†Department of Civil and Environmental Engineering
Universitá degli Studi di Perugia
Via G. Duranti, 93 06125 Perugia, Italy
e-mail: claudio.tamagnini@unipg.it

ABSTRACT

In this work, a fully coupled hydromechanical Isogeometric (IGA) Finite Element implementation is presented for saturated soils modeled as 2^{nd} gradient elastoplastic materials, based on the general framework laid out in refs. [1]. When applied to constrained micromorphic media, IGA offers the advantage of providing higher–order continuity of the approximating functions across element boundaries, which allows a more efficient and straightforward implementation of the discrete equilibrium problem, as compared to existing mixed FE formulations based on conventional polynomial shape functions [2]. This feature is also very important in coupled hydromechanical problems. In fact, the smoothness of the approximated displacements and pore pressure fields can mitigate significantly the requirements for minimum time steps.

The 2^{nd} gradient elastoplastic model adopted is based on two independent plastic mechanisms. A three-invariant isotropic–hardening elastoplastic model for bonded soils [3] is used to describe the standard part of the constitutive equation for the solid skeleton. A simple elastoplastic formulation is adopted for the 2^{nd} gradient part of the model.

The simulation of some consolidation problems demonstrates the good performance of the IGA implementation of the model, and shows its effectiveness in regularizing the FE solutions when localization patterns occur in the strain field.

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