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An incremental micro-macro model for porous geomaterials with double porosity and inclusion

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Abstract

This paper is devoted to micro-mechanical analysis of heterogeneous rock-like materials with two populations of pores as well as mineral inclusions. This work is an extension of the previous works devoted to materials with a single population of pores in (Shen et al., 2012, 2013a,b). A three-step homogenization procedure is developed. During the first step, the effective plastic yield function is determined in an analytical form for a porous medium constituted of Drucker-Prager solid matrix and microscopic pores. An analytical effective plastic yield function is then obtained by the second homogenization step for a porous materials containing a porous matrix and mesoscopic pores. During the last step, the macroscopic plastic behavior of heterogenous materials is determined by considering effects of mineral grains and by using an incremental approach. In parallel, the effective elastic properties of heterogenous materials are also estimated by the three-step homogenization procedure with a Mori-Tanaka scheme by considering effects of two populations of pores and inclusions. A non-associated plastic potential is also postulated. The proposed model is applied to two typical heterogenous rock-like materials, claystone and mortar. Comparisons between numerical results and experimental data show that the micro-mechanical model is able to capture main features of a class of rock-like materials with complex micro-structures.

Keywords: Homogenization, Micro-mechanics, Plasticity, Double porosity, Porous materials, Claystone, Mortar