

Double-Porosity Soils with Highly Conductive Inclusions: Modeling of Water Flow in Unsaturated Conditions

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The paper presents a macroscopic model of water flow in an unsaturated double-porosity soil. The soil consists of highly conductive inclusions embedded in a much less conductive matrix. The flow at local scale in both sub-domains is governed by a nonlinear diffusion-type equation (Richards equation) for the capillary pressure. Application of the homogenization method by the asymptotic expansion leads to a one-equation macroscopic flow model with two effective parameters. The effective water capacity depends on the specific water capacities of the matrix and inclusions and their volumetric fractions. The effective conductivity tensor depends on the conductivity of the porous matrix and its local geometry. It is not influenced by the conductivity of inclusions. The domain of validity of the model is defined. An example of numerical simulation (REMOL_1D) is presented for the macroscopically 1D infiltration into an initially dry soil. The results obtained by homogenization are in good agreement with a fine scale solution where the local 2D heterogeneous structure is explicitly represented (SWMS_2D).

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