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MECHANICALLY CONSISTENT MULTISCALE FORMULATION FOR SATURATED POROUS MEDIA WITH RANDOMLY DISTRIBUTED SOLID (NON-POROUS) INCLUSIONS

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Abstract. A large variety of composite materials has been addressed by using multiscale paradigms based on the notion of Representative Volume Element (RVE). Despite all the progress achieved, the case of an inhomogeneous media whose internal micro-structure is a mixture of components, each of them requiring dissimilar numbers of primary fields to describe their physical behaviour, has not yet been properly tackled in current literature. This kind of problem becomes even more complex if the constituents are randomly distributed along the micro-scale domain. A saturated porous matrix (described by displacement/pore pressure fields) endowed with impermeable non-porous solid inclusions (described solely by displacement field), represents a practical application case. In this work, we present a novel RVE-based formulation that addresses the above phenomenology at a micro-scale, exhibiting the following features: (i) it is embedded within the general framework postulated by the Method of Multiscale Virtual Power (MMVP), yielding a variationally consistent homogenization methodology, (ii) the formulation preserves objectivity with respect to the RVE-size because it is based on a recent contribution of the authors, called Selective Order Expansion (SOE) technique which guarantees, by construction, such a key property, (iii) material non-periodicity is handled by employing generalizations in the gradient homogenization formula, recently proposed by Blanco et al. (2023), to the minimally constrained kinematic multiscale models and incorporating additional restrictions on pairs of partitions along the edge of the RVE (families of sub-models included in the minimally constrained one are created). At the macro-scale, the well-known poromechanical theory is preserved, being the constitutive response given by the homogenization of the associated micro-scale problem. The multiscale formulation is implemented following the squared finite element (FE2) numerical scheme.

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