Modelling of Large Deforming Fluid Saturated Porous Media Using Homogenization Approach

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Abstract

We present a model of fluid saturated porous media undergoing large deformation. We assume the porous structure consists of hyperelastic skeleton and compressible viscous fluid. The medium is described by the Biot model constituted by poroelastic coefficients and the permeability governing the Darcy flow. The numerical solution is based on a consistent incremental formulation in the Eulerian framework [1] and on the updated Lagrangean formulation. The spatial deformed configuration is used to express the equilibrium equation and the mass conservation equation.

The homogenization method is applied to the linearized equations which result from the differentiation of model equations expressed in the residual form. The proposed upscaling approach allows us to introduce the effective medium properties involved in the incremental formulation using the homogenization of the microstructure with locally periodic structure. Modified poroelastic coefficients can be computed for given updated configurations, see [1], where the linear continua with hierarchical structures are treated. The fluid flow upscaling yields the Darcy-type flow by reason of the homogenization based on the linearized model. Using the sensitivity analysis with respect to the microsctructure deformation and the pressure perturbation, cf. [2], the sensitivity of the homogenized coefficients is computed. The resulting model is consistent with the updated-Lagrangian computational incremental scheme based on the Eulerian formulation, [3].

References

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