Rigorous Derivation of a Biot-Plate-System for a Thin Poroelastic Layer

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Abstract

We consider incompressible fluid flow in a thin poroelastic layer and rigorously derive a macroscopic model when the thickness of the layer tends to zero. Within the layer we assume a periodic structure and both, the periodicity and the thickness of the layer, are of order ε. The fluid flow is described by quasistatic Stokes-equations and for the elastic solid we consider linear elasticity equations, and both are coupled via continuity of the velocities and the normal stresses. For $\varepsilon \to 0$ the thin layer reduces to a lower dimensional manifold. Via a simultaneous homogenization (structure within the layer) and dimension reduction (thickness of the layer) we derive a limit model given by a coupled Biot-Plate-system consisting of a generalized Darcy-law coupled to a Kirchhoff-Love-type plate equation including the Darcy pressure.