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Stable numerical discretizations for the poroelasticity problem

Francisco J. Gaspar[1], **Carmen Rodrigo**[1], **Ludmil Zikatanov**[2]

SUMMARY

In this work, we treat mathematical and practical aspects of models for poroelasticity, with an emphasis on a stable numerical discretization of the system of equations.
Standard models of poroelasticity couple the equations of elastic deformation of a porous body with the effects of pressure from a fluid within the pores. However, this problem can interact with other different models to explain a more complex phenomenon describing more complicated multiphysics problems. Nowadays, poroelastic models are used to study problems in many diverse areas as geomechanics, hydrogeology, petrol engineering, biomechanics, etc. Therefore, the study of this type of problems is of great interest to scientists and engineers.
In particular, the study of the numerical difficulties that appear when solving the poroelasticity system by using standard discretizations is a current topic of discussion. Problems where the solution is smooth, are satisfactorily solved by standard finite element discretizations, however, when strong pressure gradients appear, these methods may not be stable in the sense that strong non-physical oscillations appear in the approximation of the pressure field. The oscillatory behaviour of the FEM can be minimized if methods satisfying an LBB-condition are used, however, this type of methods still give rise to solutions with oscillations, as we will show. Here we propose different strategies to obtain solutions without oscillations.

Keywords: poroelasticity, stable scheme, spurious oscillations,...

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[1]Department of Applied Mathematics
University of Zaragoza
Pedro Cerbuna, 12, 50009, Zaragoza
fjgaspar@unizar.es, carmenr@unizar.es

[2]Department of Mathematics
The Pennsylvania State University
310 McAllister building, University Park, PA, 16802
ludmil@psu.edu