The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5 – 9 June 2022, Oslo, Norway

Speeding up convergence for a coupled dynamic multi-field model for anisotropic porous materials

Nico De Marchi[1], Giovanna Xotta[1], Massimiliano Ferronato[1], Valentina Salomoni[2]

[1] Dept. of Civil, Environmental and Architectural Engineering, University of Padova,
Via Francesco Marzolo, 9, 35131 Padova, Italy.
E-mail: nico.demarchi@unipd.it, giovanna.xotta@unipd.it, massimiliano.ferronato@unipd.it
[2] Dept. of Management and Engineering, University of Padova,
Via Stradella S. Nicola, 3, 36100 Vicenza, Italy.
E-mail: valentina.salomoni@unipd.it

Key Words: *Anisotropic porous media, Biot tensor, Multi-field formulation, Mixed Finite Element modelling, Preconditioning.*

A coupled four-field dynamic model for anisotropic porous materials, whose fully implicit solution is appropriately accelerated via an ad-hoc Multi-Physics Reduction (MPR) preconditioning technique, is proposed here [1]. The preconditioned Bi-Conjugate Gradient Stabilized (Bi-CGStab) algorithm, suited for large size problems, is used as a solver.
The multi-field formulation of the dynamic partial differential equations is developed starting from the mixture theory and the definition of the effective stress for anisotropic poro-elasticity. The model also takes into account fluid phase compressibility and anisotropic permeability, and the effective stress principle is properly extended to predict the anisotropic coupling of the partial stress of the solid skeleton and that of the pore fluid [2].
Numerical solution of the coupled problem in space is obtained by using the finite element method (FEM), with stable inf-sup discretizations [3], while the system is solved in time by the standard θ-method.
These improvements are implemented in the GeoMatFem three-dimensional finite element research code and several numerical analyses are carried out to verify the capability and efficiency of the proposed numerical tool. Specifically, investigations of wave propagation in soils, relevant phenomena for earthquake engineering, reservoir management and biomechanics of bones and tissues.

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