

Accepted Manuscript

Enriched Galerkin finite elements for coupled poromechanics with local mass conservation

Jinhyun Choo, Sanghyun Lee

PII: S0045-7825(18)30320-7
DOI: <https://doi.org/10.1016/j.cma.2018.06.022>
Reference: CMA 11960

To appear in: *Comput. Methods Appl. Mech. Engrg.*

Received date: 31 January 2018

Revised date: 10 May 2018

Accepted date: 14 June 2018

Please cite this article as: J. Choo, S. Lee, Enriched Galerkin finite elements for coupled poromechanics with local mass conservation, *Comput. Methods Appl. Mech. Engrg.* (2018), <https://doi.org/10.1016/j.cma.2018.06.022>

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.



Enriched Galerkin finite elements for coupled poromechanics with local mass conservation

Jinhyun Choo^{a,*}, Sanghyun Lee^b

^a*Department of Civil Engineering, The University of Hong Kong, Pokfulam, Hong Kong*

^b*Department of Mathematics, Florida State University, Tallahassee, FL 32306, United States*

Abstract

Robust and efficient discretization methods for coupled poromechanical problems are critical to address a wide range of problems related to civil infrastructure, energy resources, and environmental sustainability. In this work, we propose a new finite element formulation for coupled poromechanical problems that ensures local (element-wise) mass conservation. The proposed formulation draws on the so-called enriched Galerkin method, which augments piecewise constant functions to the classical continuous Galerkin finite element method. These additional degrees of freedom allow us to obtain a locally conservative and nonconforming solution for the pore pressure field. The enriched and continuous Galerkin formulations are compared in several numerical examples ranging from a benchmark consolidation problem to a complex problem that involves plastic deformation due to unsaturated flow in a heterogeneous porous medium. The results of these examples show not only that the proposed method provides local mass conservation, but also that local mass conservation can be crucial to accurate simulation of deformation processes in fluid-infiltrated porous materials.

Keywords: enriched Galerkin method, finite element method, coupled poromechanics, local mass conservation

1. Introduction

In porous materials such as soils and rocks, flow of the pore fluid can give rise to significant deformation of the solid matrix, and vice versa. These poromechanical interactions are central to many important problems that relate to civil engineering [1–6], energy resources [7–10], and environmental sustainability [11–18]. Mathematically, a poromechanical problem is described by a coupled system of two partial differential equations: (1) the linear momentum balance equation which governs the solid deformation, and (2) the mass balance equation which governs the fluid flow. Numerical methods for this coupled system is the focus of the present paper.

The continuous Galerkin (CG) finite element method is one of the most widely used methods to numerically solve a coupled poromechanical formulation (*e.g.*, [19–38]). The use of the CG

*Corresponding Author

Email addresses: jchoo@hku.hk (Jinhyun Choo), lee@math.fsu.edu (Sanghyun Lee)

Download English Version:

<https://daneshyari.com/en/article/6915270>

Download Persian Version:

<https://daneshyari.com/article/6915270>

[Daneshyari.com](https://daneshyari.com)