Accepted Manuscript

A stabilized finite element method for the two-field and three-field Stokes eigenvalue problems

Önder Türk, Daniele Boffi, Ramon Codina

PII: S0045-7825(16)30868-4
DOI: http://dx.doi.org/10.1016/j.cma.2016.08.003
Reference: CMA 11084

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

Received date: 26 February 2016
Revised date: 26 July 2016
Accepted date: 1 August 2016

Please cite this article as: Ö. Türk, D. Boffi, R. Codina, A stabilized finite element method for the two-field and three-field Stokes eigenvalue problems, *Comput. Methods Appl. Mech. Engrg.* (2016), http://dx.doi.org/10.1016/j.cma.2016.08.003

A stabilized finite element method for the two-field and three-field Stokes eigenvalue problems

Önder Türk[a,b], Daniele Boffi[c], Ramon Codina[a,*]

[a] *Universitat Politècnica de Catalunya, Barcelona, Spain*
[b] *Gebze Technical University, Gebze/Kocaeli, Turkey*
[c] *Università di Pavia, Pavia, Italy*

Abstract

In this paper, the stabilized finite element approximation of the Stokes eigenvalue problems is considered for both the two-field (displacement-pressure) and the three-field (stress-displacement-pressure) formulations. The method presented is based on a subgrid scale concept, and depends on the approximation of the unresolvable scales of the continuous solution. In general, subgrid scale techniques consist in the addition of a residual based term to the basic Galerkin formulation. The application of a standard residual based stabilization method to a linear eigenvalue problem leads to a quadratic eigenvalue problem in discrete form which is physically inconvenient. As a distinguished feature of the present study, we take the space of the unresolved subscales orthogonal to the finite element space, which promises a remedy to the above mentioned complication. In essence, we put forward that only if the orthogonal projection is used, the residual is simplified and the use of term by term stabilization is allowed. Thus, we do not need to put the whole residual in the formulation, and the linear eigenproblem form is recovered properly. We prove that the method applied is convergent, and present the error estimates for the eigenvalues and the eigenfunctions. We report several numerical tests in order to illustrate that the theoretical results are validated.

Keywords: Stokes eigenvalue problem, stabilized finite elements, two-field, three-field

*Corresponding author. Tel:+34934016486.
Email addresses: onder.turk@yandex.com (Önder Türk), daniele.boffi@unipv.it (Daniele Boffi), ramon.codina@upc.edu (Ramon Codina)