



Contribution ID: 147

Type: **Oral 20 Minutes**

BLOCK PRECONDITIONING IN THE NUMERICAL SIMULATION OF FRACTURED MEDIA

Thursday, 17 May 2018 14:38 (15 minutes)

Accurate simulation of fault and fracture mechanics is a key component in a wide number of subsurface engineering applications. Faults and fractures are typically treated by modelers as discontinuity surfaces embedded in three dimensional (3D) continuous media. From a mathematical standpoint, they are described as internal boundaries whose behavior is governed by the displacement and stress fields acting on the surrounding continuum. Displacements and stresses are in turn influenced by geometrical features of the domain, thus yielding a strongly coupled non-linear problem where the domain boundary definition is itself part of the solution. Here, we focus on efficient preconditioning techniques for the linear systems arising from the discretization and linearization of the governing equations that describe the mechanics of faulted and fractured geological media based on a Lagrange-multiplier formulation.

The application of the fracture model to large-scale problems gives rise to a set of sparse discrete systems of linearized equations with a generalized non-symmetric saddle point structure. The quality and performance of the preconditioner relies on two factors: (i) the preconditioning of the leading (1,1) block and (ii) the Schur complement computation. In this work, we propose and compare various approximations for both elements.

The preconditioner of the leading block has to be selected among the wide set of choices available for elastic problems, i.e., incomplete factorizations, approximate inverses and multigrid approaches, especially on a parallel environment. On the other hand, the computation of the Schur complement can be addressed by using a sparse approximate inverse of the leading block or a physically-based block diagonal algorithm. The Schur complement must be inverted, thus other possibilities come in. The approximate Schur complement can be solved exactly, or its inverse can be directly approximated by a least-square commutator projecting the displacement variables on the space of the Lagrange multipliers. Some test cases are presented to investigate the computational performance and highlight pros and cons of the proposed approaches. Finally, real-world examples are presented and solved in an HPC environment.

References

Acceptance of Terms and Conditions

[Click here to agree](#)

Primary authors: Prof. FERRONATO, Massimiliano (University of Padova); Dr FRANCESCHINI, Andrea (University of Padova); Dr CASTELLETTO, Nicola (Stanford University); Dr WHITE, Joshua A. (Lawrence Livermore National Laboratory)

Presenter: Prof. FERRONATO, Massimiliano (University of Padova)

Session Classification: Parallel 11-C

Track Classification: MS 2.03: Challenges in flow and transport simulations in poro-fractured media: numerical methods and modeling