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REVERSE CONSTRAINT PRECONDITIONING FOR POROMECHANICAL SIMULATIONS IN FRACTURED MEDIA

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The accurate simulation of the complex mechanical behavior of faulted and fractured porous media is of paramount importance in a growing number of engineering applications. The mathematical description is usually challenging because of the strong coupling between fractures and mechanical deformation. In particular, frictional contact mechanics often represents the main numerical issue, which produces a stiff non-linear problem associated to an ill-conditioned linearized Jacobian matrix with a saddle-point structure. We enforce the constraint using Lagrange multipliers and deal with different discretizations, either intrinsically stable or requiring a stabilization correction [1].

The focus of this work is on the development of effective preconditioning strategies for the iterative solution of the Jacobian linear system arising from these applications. We propose a reverse constraint preconditioner based on the approximate elimination of the Lagrange multiplier unknowns. In such a way, the primal Schur complement inherits the same properties as a classical elasticity matrix with a locally augmented stiffness, so that state-of-the-art multigrid techniques for structural problems, such as those presented in [2], can be efficiently used. A suitable strategy for the augmentation in the intrinsically stable case is presented, allowing for an effective use of the proposed algorithm also with singular elasticity blocks. Finally, we provide numerical evidence of the robustness, computational efficiency and parallel degree by solving large size problems from various applications.

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