A Reverse Constrained Preconditioner for saddle-point matrices in contact mechanics

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The accurate simulation of fault and fracture behavior is of great importance in the context of geomechanics. While several phenomena need to be captured, such as micro-seismicity and fracture propagation, their physical description is quite complex, due to the strong coupling between fractures and mechanical deformation. The frictional contact problem is the main challenge of this effort, producing a stiff non-linear problem associated with linearized Jacobian matrices that are difficult to solve efficiently. We enforce the constraint using Lagrange multipliers and deal with two different discretizations, one intrinsically stable and the other requiring a stabilization correction [1]. The focus of this presentation is on preconditioning strategies for the arising saddle-point Jacobian matrices. We propose a constraint preconditioner based on the elimination of the Lagrange multipliers unknowns. In such a way, the primal Schur complement is similar to a stiffness matrix and state-of-the-art multigrid techniques for structural matrices [2] are very effective. Suitable augmentation for the intrinsically stable case is presented. We provide numerical evidences of the robustness and efficiency by solving large size problems from various applications.

Joint work with M. Frigo, C. Janna *and* M. Ferronato.

References

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[2] G. Isotton, M. Frigo, N. Spiezia and C. Janna, *Chronos: A general purpose classical AMG solver for High Performance Computing*, SIAM J. Sci. Comput., 43(5) (2021), pp. C335–C357.