Addressing volumetric locking and near-incompressibility in the material point method

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ABSTRACT

Nearly incompressible deformations approximated in a pure displacement framework suffer from volumetric locking. To address this issue, reduced/selective quadrature techniques, as well as more advanced B-bar and F-bar type formulations, were developed and popularized in the traditional FEM community. However, the treatment of near-incompressibility is still an open issue in particle-based methods such as the material point method (MPM). In this work, we develop a new formulation to handle near-incompressibility and volumetric locking in the traditional MPM [1] and in immersed-particle methods [2]. Using the B-bar and F-bar techniques [3] as our point of departure, and borrowing from [4], we develop a technique that is based on the projection of the dilatational part of the appropriate measure of deformation onto lower-dimensional approximation spaces. The presented numerical examples exhibit reduced stress oscillations and are free of volumetric locking.

REFERENCES