<u>Mitigating volumetric locking in IGA MPM</u>

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MPM formulations suffer from different sources of numerical instabilities. In particular, when dealing with incompressible materials, volumetric locking occurs resulting in the volumetric strains being completely mispredicted. This subsequently contaminates the entire solution. The consequences of this error affect the solution of many applications that require the study of large deformations at constant volume, such as when dealing with elastoplastic critical state-based models at large strains. The material incompressibility can also be triggered in undrained conditions when dealing with saturated porous media.

Although an effort has been made to mitigate this and other sources of numerical errors in MPM, such as cell-crossing error, using higher-order basis functions in isoparametric or isogeometric frameworks, more research is needed to assess the various techniques that can be used to mitigate volumetric locking in those frameworks. This research is concerned with the implementation and assessment of the F-bar and similar smoothing techniques to enhance the higher-order MPM in isogeometric conditions. The Jacobian of the incremental deformation gradient is smoothed with a lower-order background grid, and this is compared to the simple mapping/remapping approach commonly used to smooth stresses.

The framework is assessed by means of three different examples. First, the well-known Cook's membrane problem is used as a benchmark. The Cook's membrane problem is also performed assuming coupled hydro-mechanical conditions. Then, the oedometer problem is simulated to evaluate the framework in coupled hydro-mechanical conditions for flow in incompressible materials. Finally, a total stress analysis boundary value problem of an undrained slope runout is presented. In summary, this research will provide the audience with an overview on higher order MPM to simulate large deformation in complex geometries and a simple technique to mitigate volumetric locking towards an improved numerical framework.