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A mixed Finite Element method for 3D in-elasticity problems at large strains with weakly imposed symmetry

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We present an extension of the mixed finite element for small strain elasticity to large strain problems (see Fig. 1). The finite element formulation includes four independently approximated fields, i.e. stresses, logarithm stretches, rotation vectors, and displacements. The first two are associated with conservation of linear momentum and conservation of angular momentum respectively. The other two fields are associated with the constitutive equation and the consistency condition between displacements and deformation. The relationship between the rotation vectors and rotation tensor is established by an exponential map. The stresses are approximated in $H(\mathrm{div})$ space, and the remaining three fields in L^2 space. This formulation creates a very sparse system of equations, that is simple to parallelise, thereby enabling highly-scalable and robust solvers. The FE formulation is implemented in open-source software, MoFEM [1], developed by the authors.

This novel FE technology enables us to tackle problems with nearly incompressible soft elastoplastic materials. Further, this new approach opens up the possibility for tackling robust problems in DD-driven approaches for large strains and multi-field formulations for computational plasticity and efficient error estimators for p-adaptivity.

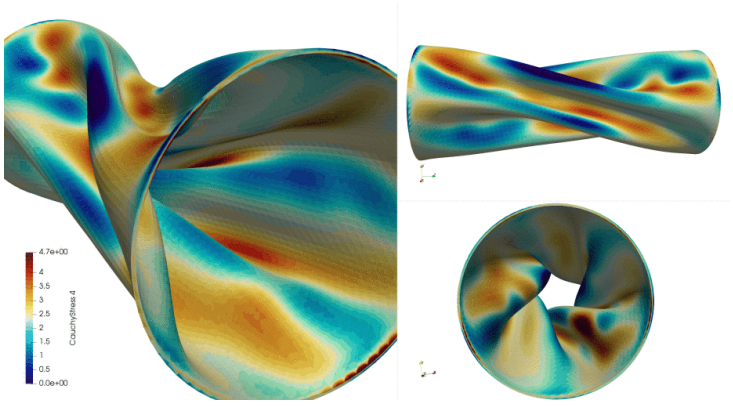

Figure 1: Deformation of nearly incompressible tube under rotation.

References

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