6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

The novel discontinuous Petrov-Galerkin Finite Element Method: Application to small and large deformations in solid mechanics

Tobias Steiner[1], **Peter Wriggers**[2]

[1] Institute of Continuum Mechanics, Appelstrasse 11, 30167 Hannover,
steiner@ikm.uni-hannover.de, www.ikm.uni-hannover.de
[2] Institute of Continuum Mechanics, Appelstrasse 11, 30167 Hannover,
wriggers@ikm.uni-hannover.de, www.ikm.uni-hannover.de

Keywords: *discontinuous Petrov-Galerkin, FEM, discretization method, solid mechanics*

Standard finite elements with lower order classical Lagrange polynomial shape functions tend to exhibit the phenomenon of volumetric locking for (nearly) incompressible materials. In this contribution the novel mixed discontinuous Petrov-Galerkin Finite Element Method (dPG FEM), which was first applied to wave transport problems and the advection-diffusion-equation (cf. [1, 2]), is introduced. The novel discretization scheme was established for linear elasticity [3] and proposed recently as a nonlinear discontinuous Petrov-Galerkin Finite Element Method [4].

In this contribution we focus on the *primal dPG FEM*. To obtain the weak form, the balance of linear momentum is integrated and weighted with a test function as in a standard Galerkin Finite Element formulation. Besides the interpolation of element displacements, the occuring boundary integrals with tractions at the interfaces of neighbouring elements are also evaluated.

In the present work a two-dimensional dPG FEM for small and large deformations is presented. The behaviour is studied with benchmark simulations and compared with established finite element formulations.

REFERENCES

[1] L. Demkowicz, J. Gopalakrishnan: A class of discontinuous Petrov-Galerkin methods. Part I: the transport equation, *Comput. Methods Appl. Mech. Engrg.* **199**, 1558–1572, 2010.

[2] L. Demkowicz, J. Gopalakrishnan: A class of discontinuous Petrov-Galerkin methods. Part II: Optimal test functions, *Numer. Methods Partial Differential Equations.* **27 (1)**, 80–105, 2011.

[3] F. Hellwig, C. Carstensen: Low-Order Discontinuous Petrov-Galerkin Finite Element Methods for Linear Elasticity, *SIAM J. Numer. Anal.* **54 (6)**, 3388–3410, 2016.

[4] C. Carstensen, P. Bringmann, F. Hellwig, P. Wriggers: Nonlinear discontinuous Petrov-Galerkin methods. *arXiv:1710.00529v1.*