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

Mixed finite element formulations for the Galerkin-based time integration of finite anisotropic elastodynamics

Julian Dietzsch[1], Michael Groß[2] and Lars Flessing[3]

[1] Technische Universität Chemnitz, Professorship of applied mechanics and dynamics
Reichenhainer Straße 70, D-09126 Chemnitz, julian.dietzsch@mb.tu-chemnitz.de
[2] michael.gross@mb.tu-chemnitz.de [3] lars.flessing@s2014.tu-chemnitz.de

In this paper, we compare new mixed finite element formulations with well-known formulations in the framework of elastodynamics. We formulate hyperelastic material behavior with an anisotropic, polyconvex formulation. On the one hand, we aim at the reduction of volumetric locking in the matrix material. Here, we compare with the well-known displacment-pressure formulation in Reference [1] and with the CoFEM element presented in Reference [3]. Further, we reduce locking in fiber direction arising from stiff fibers. Here, we compare with the SKA-element in Reference [2]. On the other hand, we aim at dynamic long-term simulations and therefore use accurate higher-order time integrators. Here, we extend the Galerkin-based time finite element method in Reference [4] to mixed finite element formulations. We apply these methods to tetrahedral and hexahedral elements up to a cubic approximation in space and time. As numerical examples serve cooks cantilever beam as in Reference [3] and a rotating heatpipe as in Reference [5]. But in the present paper, the bodies have multiple different material domains and families of fibers. The Dirichlet boundary conditions are modelled by the Lagrange-multiplier method and as Neumann boundary condition a pressure distribution is used.

REFERENCES

[1] Simo J.C., Taylor R.L. and Pister K.S. (1985) Variational and projection methods for the volume constraint in finite deformation elasto-plasticity. *Comput. Methods Appl. Mech. Engrg.*, 51:177–208.

[2] Schröder, J., Viebahn, V., Wriggers, P., Balzani, D. (2016) A novel mixed finite element for finite anisotropic elasticity; the SKA-element Simplified Kinematics for Anisotropy. *Comput. Methods Appl. Mech. Engrg.*, 310:475–494.

[3] Schröder, J., Wriggers, P., Balzani, D. (2011) A new mixed finite element based on different approximations of the minors of deformation tensors. *Comput. Methods Appl. Mech. Engrg.*, 49:3583–3600.

[4] Erler N. and Groß M. (2015) Energy-momentum conserving higher-order time integration of nonlinear dynamics of finite elastic fiber-reinforced continua. *Computational Mechanics*, 55:921–942.

[5] Groß, M., Dietzsch., J. (2017) Variational-based energymomentum schemes of higher-order for elastic fiber-reinforced continua. *Comput. Methods Appl. Mech. Engrg.*, 320:509–542.