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NURBS-BASED ISOGEOMETRIC ANALYSIS OF 3D FINITE DEFORMATION ELASTOPLASTIC CONTACT PROBLEMS

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Large deformation elastoplastic contact problems in general involve geometrical, material and contact nonlinearities, which need to be solved simultaneously. Non-smooth C^0-continuous finite element discretization techniques still constitute the most widely used approach in solving computational contact problems. In order to improve the performance of contact algorithms, various smoothing techniques have been proposed based on, e.g., Hermite C^1, Bézier and NURBS discretization of the contact surface. Although surface smoothing improves the evolution of the contact pressure, these approaches in general do not preserve consistency between volume and surface discretization. Within the framework of isogeometric analysis, smooth surface discretization can be achieved by representing the contact geometry by a NURBS surface that is directly inherited from the NURBS discretization of the volume.

The penalty (PL) method leads to a pure displacement formulation where the constraints are enforced approximately. To avoid the wellknown drawbacks of the PL method, the augmented Lagrangian (AL) method as proposed by Alart and Curnier [1] has been adopted. Herein we apply a mortar-based approach to satisfy the contact constraints combined with the AL method, which is characterized by a remarkable degree of robustness and yields an asymptotic quadratic convergence rate in the Newton iterations. For comparison purposes, we have also implemented the PL method and C^0-continuous Lagrange polynomial elements. In this paper mortar-based isogeometric analysis as formulated by De Lorenzis *et al.* [2] has been used to model finite deformation elastoplastic frictionless contact problems between deformable and rigid bodies.

A large deformation plain strain example is considered to demonstrate that isogeometric surface discretization delivers more accurate and robust predictions of the response compared to Lagrange discretization. A rigid cylinder is pressed vertically into a rectangular

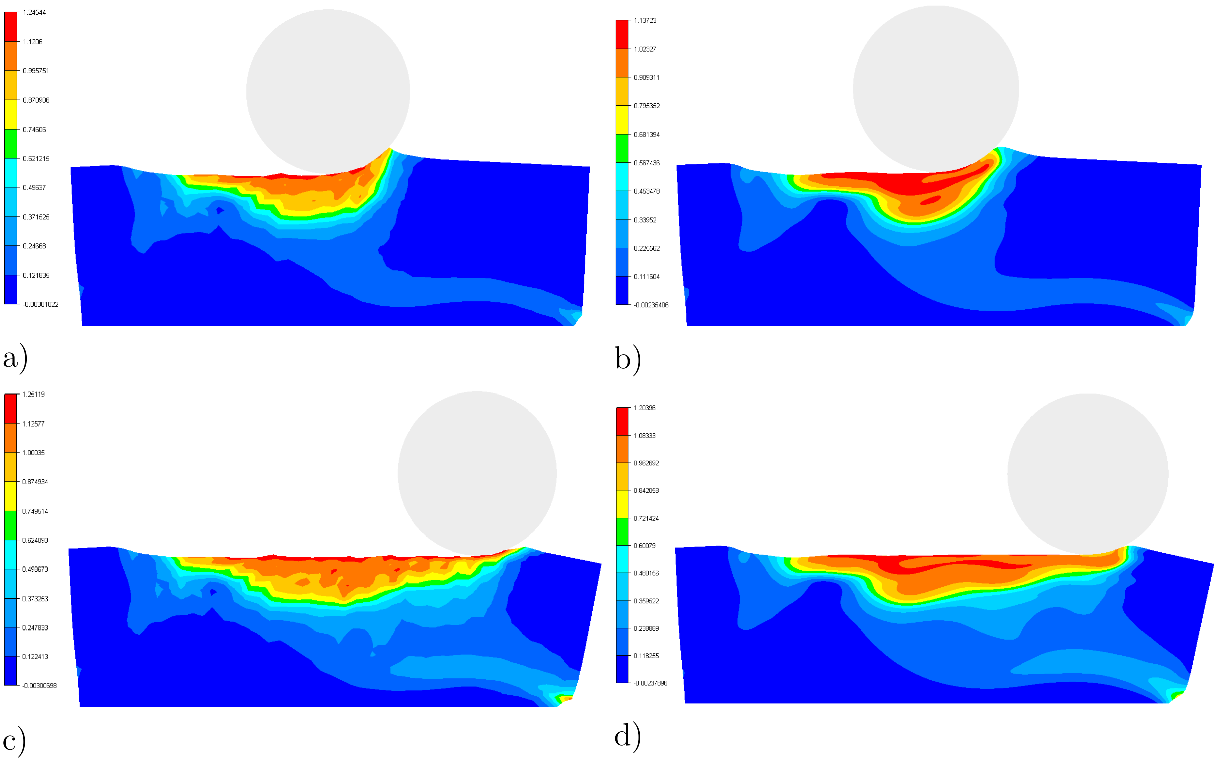

Figure 1: Ironing problem – Equivalent plastic strain: a) Q2 Lagrange, $u = 1$. b) Q2 NURBS, $u = 1$. c) Q2 Lagrange, $u = 2$. d) Q2 NURBS, $u = 2$.

slab ($v = -0.075$) and then moved in the horizontal direction ($u = 2$). The problem has been assessed in the finite deformation regime with a J_2−finite strain model with an associative flow rule based on von Mises yield criterion with isotropic hardening following a saturation law for the plastic part. Figure 1 shows the L_2-projected equivalent plastic strain plotted on the deformed configurations for an imposed horizontal displacement of the cylinder $u = 1$ and $u = 2$ for the quadratic order of NURBS and Lagrange discretizations, respectively. All results are shown with different scales adapted to the minimum and maximum values obtained in each case. For the Lagrange discretizations, we can clearly see oscillation patterns in the solution field for the equivalent plastic strain, while in contrast the NURBS solutions are smooth. Although we observe oscillations in the equivalent plastic strain, the global measure in terms of energy is almost coinciding between the various Lagrange and NURBS discretizations.

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