Finite element simulation of electromagnetic metal forming

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Electromagnetic metal forming is a high speed forming process in which strain rates of over 1000 s^{-1} are achieved. The deformation of the work piece is driven by the Lorentz force, a material body force, which results from the interaction of eddy currents induced by a pulsed magnetic field with the triggering magnetic field itself. In this talk, a mathematical model of the coupled process is presented that is based on a rate-dependent elasto-viscoplastic material model in a dynamic large deformation context on the mechanical side and on the quasistatic approximation to Maxwell's equations on the electromagnetic side. Then, a finite element discretization is derived both for the mechanical and for the electromagnetic subsystem. While standard finite element methods suffice for the mechanical subsystem, the electromagnetic equations are discretized with the help of edge elements. The electromagnetic field equations are transformed into an arbitrary Lagrangian Eulerian (ALE) formulation to guarantee a precise data transfer between the two finite element meshes involved. The coupled system is finally solved by an implicit staggered scheme. After simulation results have been presented, methods of a posteriori error control for the particular subsystems as well as for the coupled system are discussed.

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