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Mon-Mo-Po1.02-01 [13]: Parametric Sensitivity Characteristics of Numerical Simulations on EMF Free Bulging of Circular Sheet Metal

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Electromagnetic forming (EMF) processes of sheet metal are used to manufacture several components in modern industry. The EMF process is a highly nonlinear phenomenon and its understanding is a complex task due to the coupling of the electrical, magnetic, thermal and mechanical problems. The generated electromagnetic forces in this process are directly correlated to the resulting deformed workpiece geometry and strongly dependent on EMF system parameters as capacitance, initial capacitor energy, tool geometry, and its electrical conductivity, inductance, and mechanical properties. This study focuses on performing a parametric sensitivity analysis by numerical simulations of free bulging of circular sheet metal aiming a high and adequate force distribution from the EMF system. The numerical method solves the electromagnetic problem using an in-house script implemented in Matlab and then the mechanical problem is solved using the ABAQUS/Explicit Finite Element software. In the presented method, the EMF process is treated as fully coupled electric-magnetic and uncoupled with the mechanical problem, solving electrical circuits, identifying their parameters, and presenting calculations method for the magnetic flux density, the self and mutual inductances, and the electromagnetic force distribution regarding coil geometry to the initial time instant. The electromagnetic force calculated with Matlab is employed in a user subroutine of ABAQUS/Explicit to predict the movement of the workpiece. The research methodology involves a parametric sensitivity analysis considering the following design variables parameters of EMF devices: system capacitance, energy pulse, and tool coil geometry. Finally, conclusions and design principles for the free bulging of sheet metal by EMF are outlined.

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