Chair of Metal Forming and Casting
TUM School of Engineering and Design
Technical University of Munich

TUM

Geometry-based compensation of dimensional deviations in bulk metal forming

Final Report

Motivation

In bulk metal forming, deviations from the desired component geometry often occur. A precise design of the tools is crucial in order to achieve the approximation of the actual geometry to the target geometry of the part. The compensation of deterministic dimensional deviations currently consists of a very time-consuming iterative process, in which the CAD geometry of the tool is adapted in order to modify the FE mesh. To make this process more efficient, a stress-based compensation on a reference point-based replacement model of the part is proposed.

Method

First, it is necessary to be able to derive the replacement model from the target geometry. For this purpose, the most important points univocally representing the target geometry are identified by the user and selected as reference points. The deviations of the actual geometry from the target geometry are hence measured only at such reference points. Once the replacement model has been decided, the compensation can be carried out. The innovative approach used in the project is a stress-based methodology that can reproduce the adapted tool geometry relying only on the part target geometry. In a first linear elastic finite element analysis, the target geometry is deformed to the measured actual geometry. This is achieved by applying displacement boundary conditions to the nodes, which are derived from the values of the deviations at the reference points. In this deformed configuration, which now corresponds to the measured actual geometry, the stress state is recorded. In a subsequent again linear-elastic FE calculation, this stress state is then applied to the original target geometry. As a result of the stress relaxation, a new configuration is obtained, which represents the adjusted target geometry.
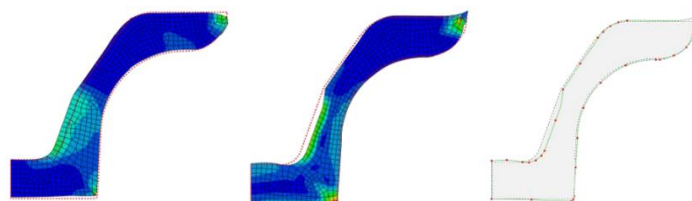
Assuming that the tool geometry corresponds to the

Figure 1. Numerical tool compensation and resulting geometry

target geometry during forming, the adapted tool geometry can then be obtained, leading to significantly less deviating final parts.

Results and Outlook

An innovative compensation methodology based on residual stresses is developed to minimize dimensional deviations in bulk metal forming. A crucial step in the compensation strategy is the description of the geometry through a reference point based replacement model and the conversion from the CAD to the FEM world.