Optimization strategies and statistical analysis for springback compensation in sheet metal forming

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ABSTRACT

Geometrical inaccuracies of sheet metal parts due to springback are one of the main sources of their lack of dimensional accuracy. When designing the process to obtain a desired geometry for a sheet metal part, it is mandatory to take into consideration its springback behaviour. This requires making tool geometry or in any process variable adjustments. These modifications are classified as springback compensations and several strategies can be used to reduce the shape deviations between the target geometry and the actual result of the forming operation. One of several strategies to perform springback compensation in metal forming is to change the tool geometry, the initial blank shape or the blank holder force. However, the number and complexity of this parameter set makes this task, if it would be done experimentally, very material and time consuming. A possible solution is the use of numerical optimisation strategies, such as, for instance, Response Surface Methods (RSM) or ANOVA. Nevertheless, there is no consensus considering the most effective strategy.

This paper presents an analysis and comparison between several numerical strategies for springback compensation, including: (i) a statistical approach based on a factorial experiment design (DoE) and statistical analysis using ANOVA (Analysis of Variance), (ii) response surface methodologies, namely polynomial regression and Universal Kriging, that are a collection of statistical techniques, based on the good fitting of experimental data through polynomial fitting and an optimization approach, (iii) least-square gradient-based methods.

All strategies are applied to the springback compensation of a U-shaped rail, a well-known benchmark that shows large elastic deflections after the tooling removing. The results are compared with the ones obtained by other authors.

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