Improving numerical predictability of Springback

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Introduction

Finite element software is used in the design process of new sheet metal parts (fig. 1). During the process the amount of springback (elastically-driven change of product shape) is numerically predicted. This information, being used in tools design phase, ensures that the desired product shape will be reached. Current accuracy of numerical prediction of springback is insufficient. Required surfaces of tools can only be obtained after employing the extensive experimental trial and error process.

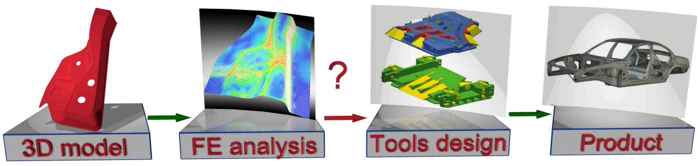

Figure 1: Schematic of the design process.

Objective

The major goal of the project is to improve the numerical predictability of springback to meet industrial requirements.

Methods

Additional sensitivity analysis of springback performed on several characteristic components (fig. 2) showed that:

- increasing coefficient of friction does not necessarily decrease springback, i.e. in a situation when a change of shape is dominated by a relaxation of membrane stresses;
- iterative solver can deliver an inaccurate solution and should be applied with caution.

Results

Mesh density. Recommendations, available in the literature, were tested using the U-bending problem. Results showed that an optimal discretisation level strongly depends on in-plane tension, R/t ratio and material properties. To understand this dependency a simple model of a beam under combined bending moment and tension was built. The model is used to develop practical guidelines that define an appropriate mesh density to assure the required accuracy of springback prediction.

Figure 2: Characteristic component 3.

Drawbead model. Simulations of NUMISHEET05 benchmark showed that physical drawbeads provide better springback prediction than line beads. Due to simplifying assumptions, an equivalent drawbead model can fail to predict a realistic stress state (fig. 3).

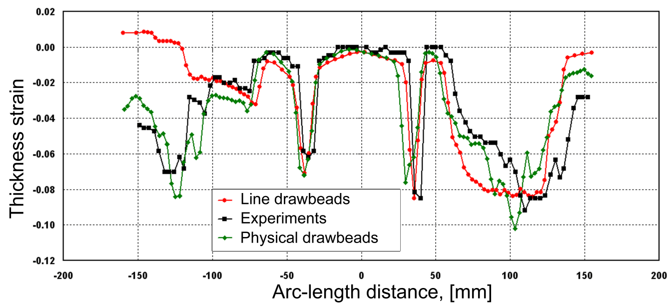

Figure 3: Thickness strain distribution in a product cross-section.

Future work & Valorisation

Authors in [1] showed that depending on material and process parameters 30-68 integration points through the thickness are required to reach 1% of springback accuracy. Accurate analysis of a plastically deforming sheet material requires that an integration point lies on a position where yielding occurs. An attractive approach is to perform a through-thickness integration by an algorithm that adapts sampling points to the stress situation. The adaptability may include changing a location of integration points and/or changing their absolute number. This adaptive integration algorithm can help to achieve 1% accuracy of springback prediction at minimal costs.

References

[1] Wagoner, R. H. and Li, M. "Advances in springback." in proc. Numisheet 2005. Detroit, MI, U.S.A., p.209-214.

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