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

Failure Assessment of Bending Operations with Pre-stretched Sheets (3D-BFLC)

Motivation

Many sheet metal parts go through a bending operation during the manufacturing process. Compared to deep-drawing operations, the prediction of failure in bending operations cannot be predicted with a forming limit curve from the Nakajima or Marciniak experiment. Due to the small bending radius and the associated strong curvature, the failure only occurs by significantly higher strains. Likewise, the failure will not be caused by a local constriction, but by damage to the outer areas of the sample.

The introduction of pre-strains in the material leads to a development of texture and damage. Since this damage depends on the direction, changing the direction of the load leads to increased damage. If such pre-stretched samples are subsequently bent, the sample may fail unexpectedly.

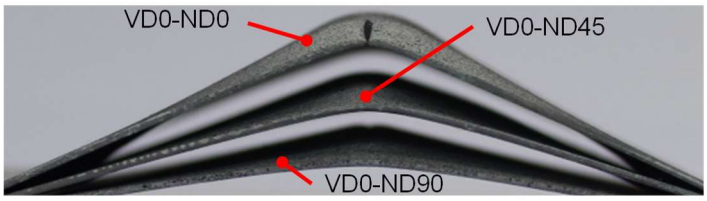

Figure 1: Influence on the bending angle.

Goals

Within the scope of this research project, the influence of the pre-stretch and the direction of loading on different materials are to be investigated. These results serve as the database for a phenomenological model to predict material failure in bending operations with pre-stretched sheets. This should increase the accuracy of the prediction and reduce the training time for tools.

By avoiding costly and time-consuming tool adjustment loops, the use of personnel, machinery, tools, and materials will be reduced, which increases the competitiveness of small and medium-sized enterprises (SMEs). By minimizing entrepreneurial risks, the planned research project can also increase process reliability during ongoing production operations, thereby reducing production downtime and scrap during series manufacturing. Predicting failure in bending operations with pre-stretched sheets allows better utilization of material potential for the specific application, which results in reducing the material consumption.

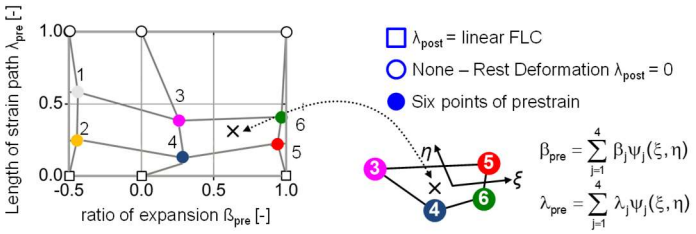

Figure 2: The structure of the meta-model.

The insights gained from this project allow SMEs to compare the strains occurring in their components with the experimentally determined data obtained from this project. This enables them to analyze the manufacturability even without implementing the methodology in simulation programs. Particularly for progressive dies, which involve various forming and bending operations, such an approach provides an additional assurance in process design.

Tianyou Liu, M.Sc.
Walther-Meissner-Str. 4
85748 Garching

Tel. +49 89 289 13 793
tianyou.liu@tum.de
www.utg.mw.tum.de

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