BLEKINGE INSTITUTE OF TECHNOLOGY

RESEARCH

PREDICTing Failure in Sheet Metal Forming

Accounting for Non-Linear Strain Paths, Edge Cracks, and Stretch-Bending

Accurate Failure Prediction

Accurate failure prediction in Sheet Metal Forming (SMF) is a core task for all Computer Aided Engineering (CAE) departments within e.g., the automotive industry. To deal with new increasingly complex issues encountered, CAE engineers need more accurate failure models with special attention to non-linear strain paths, edge cracks, and stretch bending.

Background

There is a trifactor of reasons why research into more accurate failure models is important. Firstly, an increase in accuracy in failure models will allow companies to save time and money in that start-up of production. With higher accuracy, the need for re-work of expensive dies decreases. Secondly, an increase in failure model accuracy will allow for a more accurate estimate on how new complex and more environmentally friendly materials can be implemented into the production lines. Lastly, increased failure model accuracy is a vital step towards the implementation of Industry 4.0 in Sheet Metal Forming operations.

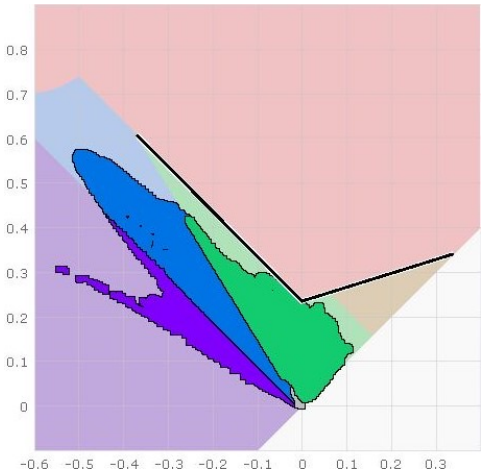
Current Focus

Currently in the PREDICT project, the focus is on Non-Linear Strain Paths (NLSP) and Edge Cracks. For failure due to NLPS, a component by Volvo Cars serves as one of the case studies. For accurate prediction, a method previously proposed by [1] and investigated by [2] is tested for this special case. The method relies on a transformation of the evaluation space to account for the material flow direction at the end of the simulation and is based on the principles of the stress based Forming Limit Diagram. Parallelly, the method of the generalized forming limit concept (GFLC) proposed by [3] is being studied to account for NLSP.

For prediction of edge cracks, a deeper look is taken at the ISO-16630 standardized Hole Expansion Test. The working hypothesis of this investigation is, that the new and more advanced AHSS alloys results in higher scatter due to an insufficient amount of restriction force during testing. A new tool to up-scale this test is currently being developed.

Both studies are currently ongoing, and results will be published at the end of 2021 and end of Q1 2022, respectively.

Volvo Cars component displaying fracture due to non-linear strain paths.



No indication of necking in simulation of Volvo Cars component.

Outlook

In the up-coming months, the focus of the project will continue to be on NLSP and edge cracks. Especially the investigation on edge cracks will be of focus where different tests (besides the ISO-16630) will be carried out at the laboratories at Blekinge Institute of Technology in Karlskrona. Where the edge formability in open vs. closed trimlines will be investigated.

References

[1] Zeng et al. (2009) "A Path Independent Forming Limit Criterion for Sheet Metal Forming Simulations". *SAE Int. J. Mater. Manu* ***1****(1) pp 809-817.*

[2] Mattiasson et al. (2014) " On the prediction of failure in metal sheet with special reference to strain path dependence". *Int. J. Mech. Sci.* ***88*** *pp 175-191.*

[3] Volk et al. (2013) "Prediction of Formability for Non-Linear Deformation History using Generalized Forming Limit Concet (GFLC)". *AIP Conf. Proceedings* ***1567****(1) pp 556-561.*

Alexander Barlo
Ph.D. Student
Dept. of Mechanical Engineering
Blekinge Institute of Technology
Alexander.Barlo@bth.se, +46 738522575

Project Consortium