# AsPro

## Fundamentals of process design for dimensionally accurate roll forming of asymmetric profile geometries*

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| **Duration** | November 2019 – September 2022 |
| **Department** | Profile Manufacturing Technology |
| **Funded by** | DFG – German Research Foundation |


**Abstract**

In this project, various asymmetrical hat and U-hat profile geometries were analysed for profile defects and measures to reduce profile defects were derived. Numerical parameter studies were used to identify correlations between process parameters and profile defects and the process parameters were optimised. Various strategies for straightening asymmetrical profiles were also investigated. An analytical model was developed to calculate the longitudinal strain distribution in roll-formed profiles based on the characteristics of the longitudinal defects.


**Project description**

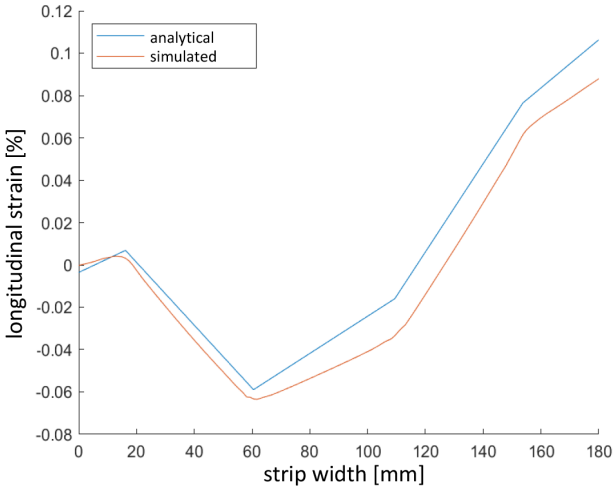
Roll forming is a continuous process for manufacturing profiles from cold-rolled material. Sheet metal strips or blanks are gradually formed into the desired shape by rotating rollers. Asymmetrical roll-formed profiles are particularly suitable for reducing the weight of means of transport due to their weight-optimised design and efficient production. However, in addition to the desired transverse bending, undesirable longitudinal strains occur, which leads to profile defects such as bowing and twisting. These defects occur particularly frequently in asymmetrical profiles. Due to a lack of fundamental knowledge about the relationship between longitudinal strains and profile defects, the roll forming process is often designed iteratively, which results in long set-up times and complex straightening operations. The project aimed to investigate the mechanisms that lead to profile defects and to develop an analytical model that quantifies these relationships. Suitable straightening operations were identified and optimised based on numerical parameter studies and experimental validations.

**Results**

In this project, the relationships between longitudinal strain distribution and profile defects in symmetrical and asymmetrical hat and U-hat profiles were investigated. An analytical model developed in the project was able to show for the first time the direct quantitative relationship between profile defects and longitudinal strain distribution. The model makes it possible to predict the longitudinal strain distribution in the profile cross-section based on the bowing and twisting of a profile. The model was validated by simulations and showed good agreement with the simulation results, as shown in Figure [1].

The simulations were also used to analyse the influence of various process parameters such as roll distance, roll diameter, roll gap and material yield point on the profile defects. It was found that all the parameters analysed have an influence on the profile defects, but no single parameter has a positive effect on all defects at the same time. Experimental validations of the simulations showed only minor deviations.

In addition, various straightening strategies for the production of asymmetrical profiles were investigated. The best results were achieved by twisting the last roll forming stand. A simulation was coupled with an optimisation algorithm to determine the optimum twisting angle of the last roll forming stand. This method significantly reduced the required number of simulations and the time to reach an optimum. Experimental evidence confirmed that twisting the last roll forming stand significantly reduces the twisting of asymmetrical profiles, which confirms the method as an effective measure for correcting profile defects.




[1] Analytically calculated and simulated longitudinal strain of a curved and twisted asymmetrical hat profile [Kilz J, Güngör B, Aign F, Groche P (2023) Profile defects caused by inhomogeneous longitudinal strain dis-tribution in roll forming. Int J Mater Form 16(4), doi:10.1007/s12289-023-01762-3.]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**Acknowledgement**
The research project was funded by the German Research Foundation (DFG) - 407937637. We would like to thank the DFG for its support in carrying out the project.

**Funded by**


*Official project title: “Fundamentals of process design for the dimensionally stable roll forming of asymmetrical profile geometries”; The process designation “roll forming” according to DIN 8586 (2003-09-00) was renamed “roll forming” in the current standard.