SFB666

Integral Sheet Metal Design with Higher Order Bifurcations

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Abstract

The work of the SFB 666 has resulted in methods and processes with which bifurcated structures made of sheet metal can be integrally manufactured with optimized properties for the respective application. The focus of the PtU was on the manufacturing process of flow splitting.

Project description

This objective includes issues of product development, manufacturing technologies and component evaluation. Therefore, scientists from the Technical University Darmstadt from the disciplines of product development, mathematics, materials science, production technology, operational stability and civil engineering have joined forces to form this interdisciplinary research network.

Results

In SFB 666, methods and processes have been found that can be used to design branched structures in integral sheet metal construction in an optimized manner with regard to their function and stress. The research activities have represented product development in a holistic sense and have therefore extended from the definition of the requirement through product design and manufacture to product testing - including virtual product development.

In many cases, branching structures enable the realization of a desired function in the smallest space or with the smallest mass. The targeted introduction of branching into structures allows them to be optimized, for example in terms of statics and stability. In many cases, nature is the model for the application of branched structures to optimize the properties and functions of products.

The state of the art for manufacturing branched structures are integral and differential construction methods. In differential construction, the structures are joined from individual components, while in integral construction the entire component consists of a single part. Integral designs - especially for metallic workpieces - have the advantage of lower susceptibility to defects or better thermal conductivity due to the presence of a continuous material bond. Likewise, the tendency to corrosion is often significantly lower. Components with differential design often suffer from undesirable thermal effects on the microstructure, e.g. in welded joints, or from damaging local stress concentrations, e.g. caused by bolted or riveted joints. Integral structures are currently realized mainly by forming or machining processes. In forming technology, solid forming processes such as extrusion, hot rolling or forging are used for this purpose. Based on this technical status, branching-like structures can only be realized by introducing beads or by material doubling. However, these do not correspond to the mathematical definition of a branch and also do not have the same optimized properties as actual branched structures. Further arguments requiring technology innovation in the manufacturing process for branched structures are both economic aspects and prevailing manufacturing restrictions that set limits to the creation of arbitrarily branched structures. In some cases, filigree branched structures are created by machining from a solid starting product because no alternative methods exist.

The new manufacturing processes of flow splitting and split profile bending offer promising possibilities for eliminating the above-mentioned deficits. The first foundations for this were laid in the DFG project GR 1818/7-2. With the SFB 666 „Integral sheet metal structures of higher order bifurcations", the process limits were extended and a product development process aimed at sheet metal in integral design was designed and implemented.

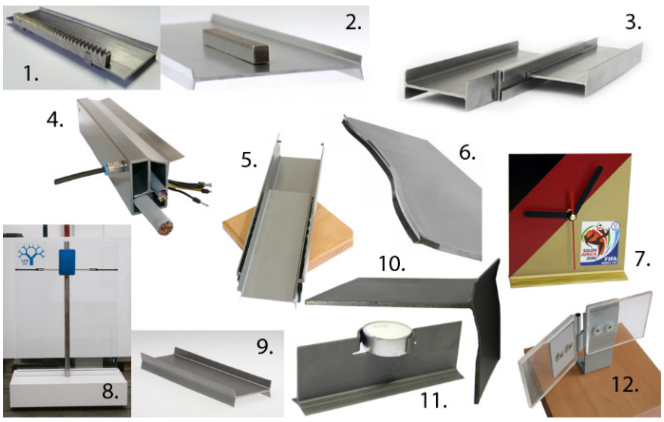
In the following is a summary of the main results and findings from SFB 666:

- Through previous numerical investigations, a possibility for the process-reliable realization of large split depths was developed and subsequently implemented.
- profiling stands for the continuous production of linear flow split profiles were designed and manufactured.
- By integrating an induction unit, it was possible to show that process limits with regard to cleavability can be improved by strip heating.
- Stringer, double-T and multi-chamber profiles were produced by further processing of split profiles through additional roll forming stages.
- Both basic investigations into flexible split profiling (with variable profile width) and the implementation of a tooling and plant concept were carried out.
- The forming process of linear bend splitting was investigated as a modification of linear flow splitting with regard to the process fundamentals.
- Furthermore, linear flow splitting was integrated into a process chain and investigated. This consists of linear flow splitting, roll forming, HSC machining and laser welding.

- The split profile bending process, which combines linear flow splitting and profile bending, was investigated and the advantages of this combined process were demonstrated.
- Joining by forming was investigated in the linear flow splitting manufacturing process. This makes it possible, for example, to frictionally join a toothed rack in the web area of the linear flow split profile as a result of the high longitudinal elongations.
- Production and optimization of components with branched sheet metal structures. See also the demonstrators in the following section.
- Numerous other results from other departments

A large number of demonstrators have been developed in SFB 666. Figure 1 shows a collage of some selected demonstrators. They are numbered and described in the following section:

1. Cross-section of a linear flow split part with joined rack
2. Linear flow split part with joined rack
3. Profile joints of split profiles
4. Multi-chamber profile for functional integration based on split profiles
5. Linear flow split parts in profile connections
6. Flexible flow splitting: flexible flow split profile with variable profile width
7. Watch with a painted linear flow split profile as a base support
8. face of a building cleaner
9. liner flow splitting profile bifurcated on both sides
10. linear bend splitting part
11. tealight holder made of a linear flow split profile
12. hinge made of linear flow split profiles



[1] A selection of demonstrators from the SFB 666

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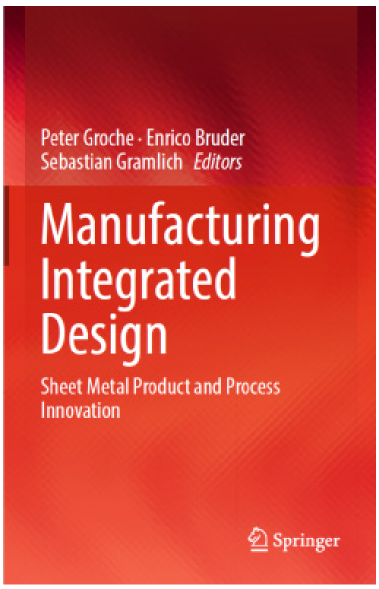
The book “Manufacturing Integrated Design”, edited by Peter Groche, Enrico Bruder and Sebastian Gramlich, is now available from Springer Verlag: Manufacturing Integrated Design

https://link.springer.com/book/10.1007/978-3-319-52377-4



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