

Design and Analysis of Freeform Shell Structures Composed of Doubly Curved Sheet Metal Panels

Alex SEITER^a, Thorsten POFAHL^a, Martin TRAUTZ^a
Lisa-Marie REITMAIER^b, Gerhard HIRT^b

^a Chair of Structures and Structural Design, RWTH Aachen University
Schinkelstraße 1, 52062 Aachen, Germany
seiter@trako.arch.rwth-aachen.de

^b Institute of Metal Forming, RWTH Aachen University
Intzestraße 10, 52056 Aachen, Germany

Abstract

Our current research deals with innovative structures made up of doubly-curved sheet metal panels and provides the realization of a wide-spanning, lightweight shell structure. This paper is a follow-up contribution to our IASS 2014 Brasilia paper in which we outlined our research proposal and our IASS 2017 Hamburg paper that discusses our technological approach and various fields of application for the production process.

The paper introduces the design and geometrical optimization of our panel assembly, the manufacturing process of those panels using a combined process of Incremental Sheet Forming and Stretch Forming as well as optimization strategies for construction space usage and minimization of production time. The main focus will be on iterative design, planning and structural analysis of the shell structure with an in depth discussion on the challenging modelization of multilayered, ultra-thin sheet metal components. Self-supporting structures of thin sheet metal enable for lightweight construction, but poses various design challenges: Global and local buckling effects and local stress phenomena such as shear and hole bearing forces. In principle, sheet metal has a high degree of formability and can be formed into individual, high complex parts with acceptable tolerances. However, the minimal thickness of the material increases susceptibility to failure of such structures caused by even small geometrical imperfections and springback effects. Therefore, accurate modelization on a very detailed scale is essential to identify and react to structural discontinuities. Such models may easily extend computational restrictions of state of the art FEA Environments. Our approach uses a custom interface of parametric CAD Modeller Rhino GH with the robust and scalable FEA Environment Ansys, shifting the entire modelling and the implementation of finite elements, loads, supports and joints to GH.

References

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- [2] T. Pofahl, G. Della Puppa, M. Trautz, D. Bailly, G. HIRT, *A new concept for freeform shell structures composed of doublycurvedmultilayered panels*, Proceedings of the IASS Annual Symposium 2014, September 15 - 19th, 2014, Brasilia.