# Topological Optimization of Elasticallybended Grid Shells

Project Type Research

#### Status In progress

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# **Question and content**

An interdisciplinary team of construction engineers, architects, and mathematicians are developing a new method for the form-finding and optimization of grid shells made from highly elastic materials (CRP [carbon fibre reinforced plastics], GRP [glass fibre reinforced plastics], NFRP [natural fibre reinforced plastics], timber and engineered timber). These highly elastic materials allow for a fast and cost-efficient assembly technique in which the initially straight rods are shaped into a particular geometry through elastic bending processes.

## **Use and Target Audience**

The first motivation for the use of active-bending is the simplification of the production, transportation, and assembling processes. The production of straight elements is much easier, faster, and cheaper than that of curved profiles. Due to the reduction of package volume the transportation of straight elements compared to curved elements is more efficient. The use of straight elements can also facilitate the assembling and erection process, as the actively-bent elements can be laid out on the ground, pre-assembled, and erected afterwards.

Despite the strong growing interest that architects and engineers have in such structures, the complexity of generating grid configurations that are deployable into free-form surfaces and the limitation of suitable materials restrict the execution of elastically-bent grid shells.

The aim of the project "Topological Optimization of Elastically-bended Grid Shells" is to develop a design and optimization methodology for elastic grid shells, which generate grid topologies adapted to determinate architectural and structural requirements. The methodology is based on non-linear variational algorithms combined with simulations using FEM for analyzing the load-bearing behavior of the structures.

## **Publications**

E. Lafuente Hernández, C. Gengnagel, S. Sechelmann, T. Rörig (2011): "On the Materiality and Structural Behaviour of Highly-elastic Gridshell Structures" In: *Computational Design Modeling: Proceedings of the Design Modeling Symposium Berlin 2011*, pp. 123–135. Springer-Verlag, Berlin Heidelberg.

E. Lafuente Hernández, S. Sechelmann, T. Rörig, C. Gengnagel (2013): "Topology Optimisation of Regular and Irregular Elastic Gridshells by Means of a Non-linear Variational Method" In: *Proceedings of the Advances in Architectural Geometry 2012*, L. Hesselgren, S. Sharma, J. Wallner, N. Baldassini, P. Bompas, J. Raynaud (eds.). Springer-Verlag, Berlin Heidelberg.

E. Lafuente Hernández, O. Baverel, C. Gengnagel (2013): "On the Design and Construction of Elastic Gridshells with Irregular Meshes" Special Issue of *International Journal of Space Structures (IJSS)*.

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