# Mechanisms of elastically bent grid structures

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## Abstract

This paper investigates elastic mechanisms of quadrilateral grid structures. Elastic deformation can be used to generate specific forms desired and compliant mechanisms hold great potentials for erection or shape adaption. The construction process of curved grid structures often demands costly scaffolding and formwork and kinematic mechanisms are complex in construction. While there is plenty of literature on the structural behavior of grid shells and grillage structures, their potential of transformation has received little attention. Previous research at the Chair of Structural Design shows, that a curvature network on a doubly curved surface directly relates to the profiles bending axis of an elastically deformed grid [1].

The elastic mechanism of a grid structure is defined by its Layout, profiles stiffness and the connections degree of freedom. In that context three major aspects are described:

Prestressed grids may contain several minimum **strain energy** stages. These stages are described and manipulated by changing the grids/profiles parameters.

When dealing with large deformations, nonlinear effects like the "**helix-torsion**" need to be considered [2]. This research gives an insight on the impact of normal stresses due to large twisting in a practical scale.

This paper presents **methods**, which have been developed to simulate and investigate such mechanisms. Isogeometric Analysis (IGA) is used to simulate the natural deformation of lamella grids. Asymptotic curvature networks are taken as start geometry. The corresponding restraint stresses including those due to helix torsion are automatically derived and a respective state of equilibrium is computed.

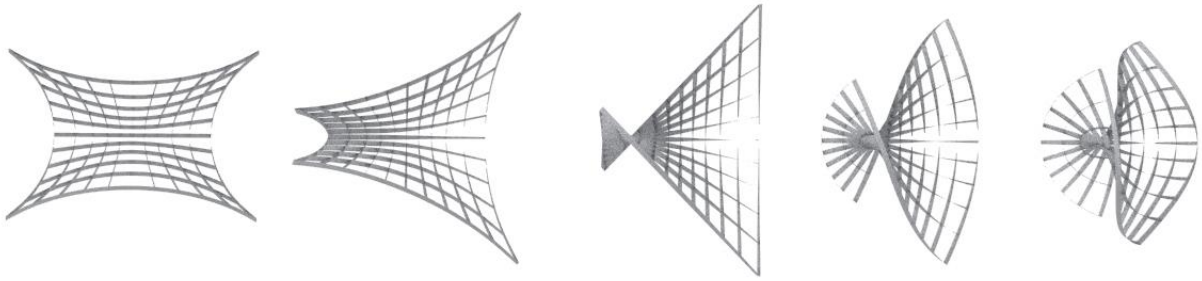

*Fig.: Natural transformation of an Asymptotic network on an Enneper Surface*

## References

[1] E. Schling, *Repetitive Structures: Design and construction of curved support structures*, Munich, 2018.

[2] G. Lumpe and V. Gensichen: *Evaluierung der linearen und nichtlinearen Stabstatik in Theorie und Software*, Berlin, 2014