

## Structural Optimization of Timoshenko Beam Networks

The goal of this work is the simulation and optimization of the deformation of large 3D beam networks exposed to external loads. The optimization shall mostly be based on the ground structure approach known from truss topology optimization. Motivated by industrial applications, the underlying beam model has to allow for effects like transport of momentum, shear deformation as well as curved geometries. On the other hand, due to the potentially large number of bars in the ground structure fast computation of the deformation field of the network by means of numerical simulation is mandatory.

In order to achieve this, a 3D-Timoshenko beam model with element-wise analytical basis functions has been implemented. The numerical results generated by this approach are validated against results using linear basis functions with different global refinements of the beam elements.

On the basis of the Timoshenko beam network model, various structural optimization problems are posed and numerical results are shown. Examples include topology and multi-material optimization with a resource constraint and compliance as objective function. To approximate discrete solutions in these cases, the candidate materials (e.g. material-void configurations or several materials chosen from a catalogue) are parameterized using a discrete interpolation scheme such as SIMP. In case of multi-material optimization, this approach is known as the Discrete Material Optimization (DMO). Some other objective functions and constraints (like displacement constraints) are investigated as well.

In the last part of this talk, shape optimization is discussed. In this case, topology of the beam network remains unchanged, but positions of the nodes are optimized. It turns out that only a small number of bars in the initial structure is required to get good optimization results. Finally, some restrictions like angle constraints between two beams are added.