Universität Stuttgart

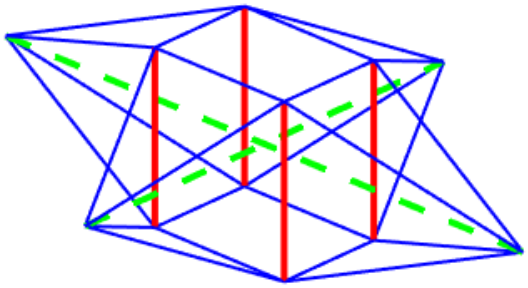
Baustatik und Baudynamik

Master Thesis

Form finding of self-stressed tensegrity structures using rank minimization

The design of tensegrity structures is still a challenging task despite long research on the topic. Recently, an elegant approach for design of self-stressed tensegrity structures was proposed by Wang et al. (2021). This approach yields the force density distribution and the geometry for a tensegrity structure based only on the topology of cables and trusses in it and additional constraints on the force densities. These force densities provide the necessary stability of the structure. In the core of the approach, a rank minimization problem of the force density matrix is solved. For this purpose, special relaxation of the rank minimization problem are used, e.g. a simple trace minimization.

The goal is to apply and improve the described method and analyse its robustness and convergence. Especially the effect of different constraints on the force densities and their effects on the rank minimization problem and the resulting shapes shall be investigated. In case studies of 2D and 3D tensegrity structures, also with a rank deficit beyond $d+1$, relations between the rank minimization problem and structural properties of the topologies can be explored.



Tasks:

- Literature study on form finding of tensegrity structures and the force density method
- Learning basics of convex optimization and CVX package in Matlab
- Implementation of form finding of tensegrity structures based on rank minimization
- Case studies of 2D and 3D examples to investigate the robustness and convergence.
- Study the influence of the constraints between force densities

Recommended fields of interest:
Form finding, tensegrity, force density method, Matlab, optimization

References

Wang, Y., Xu, X, and Luo, Y.: *Form-finding of tensegrity structures via rank minimization of force density matrix.* Engineering Structures 227 (2021), doi: 10.1016/j.engstruct.2020.111419