Assessment of Tensegrity-Based Aircraft Wings Capable of Morphing

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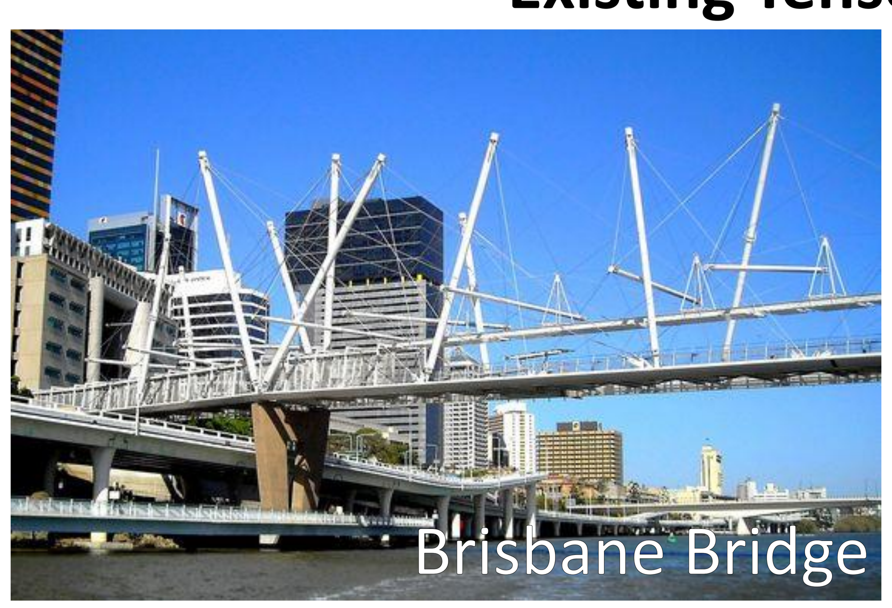
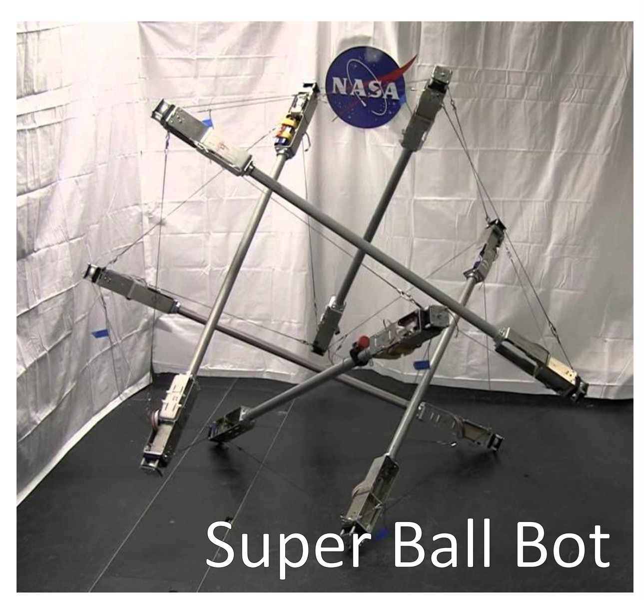
Objective: To explore and assess the viability of tensegrity systems configured as aircraft wings, produce a tensegrity wing design based on optimized topology, and perform comparison to conventional aircraft wing structures.

Introduction

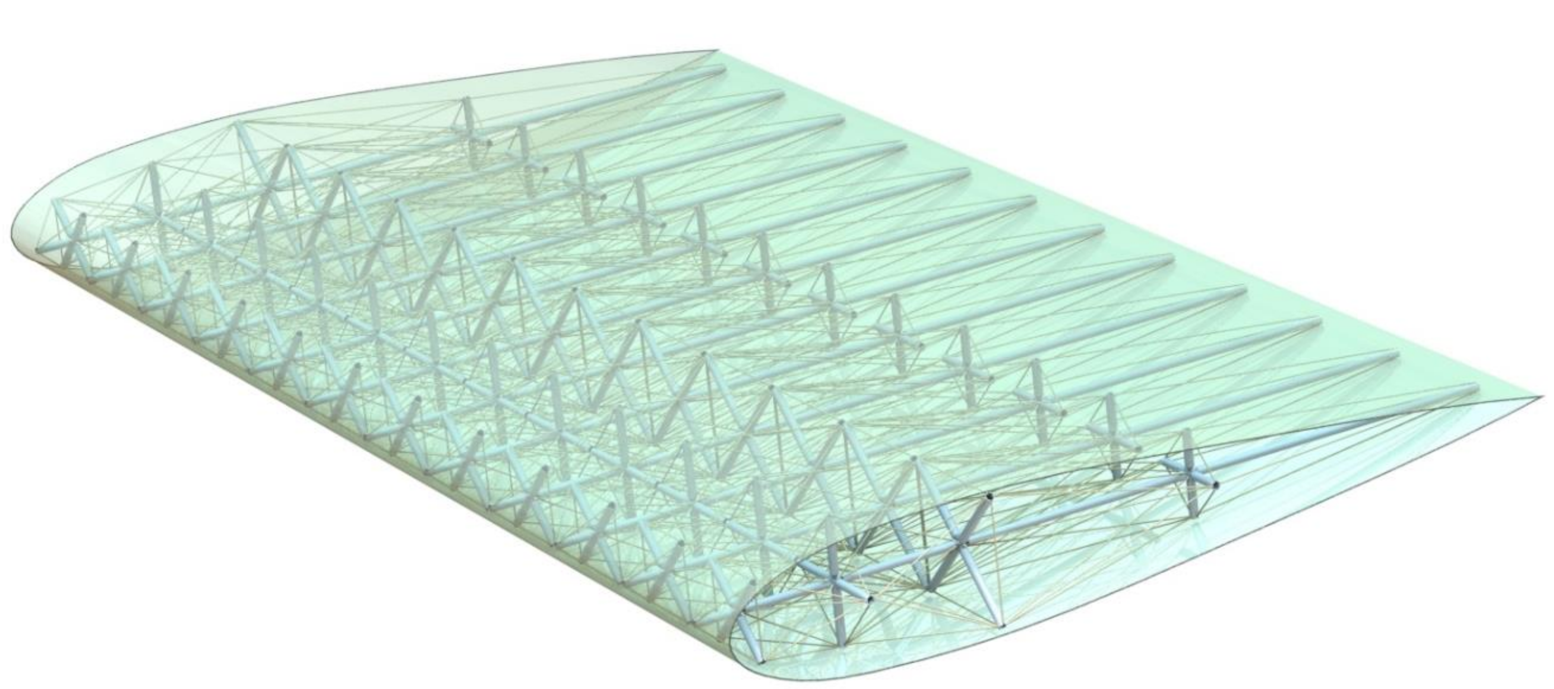
This research explores the use of tensegrity systems to serve as a strong and lightweight wing structure that is capable of morphing. Tensegrity systems consist of a series of compressed struts connected by tensioned cables that place the system in a self-equilibrium state. Tensegrity systems are able to alter shape by changing strut or cable lengths without compromising weight or rigidity requirements.

Existing Tensegrities





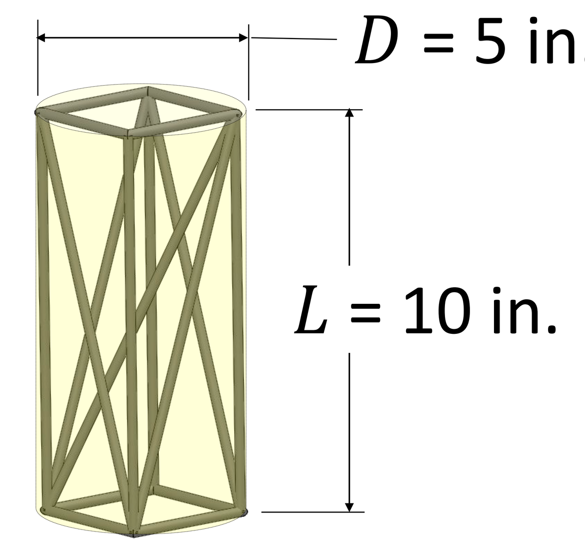
Tensegrity Wing Concept



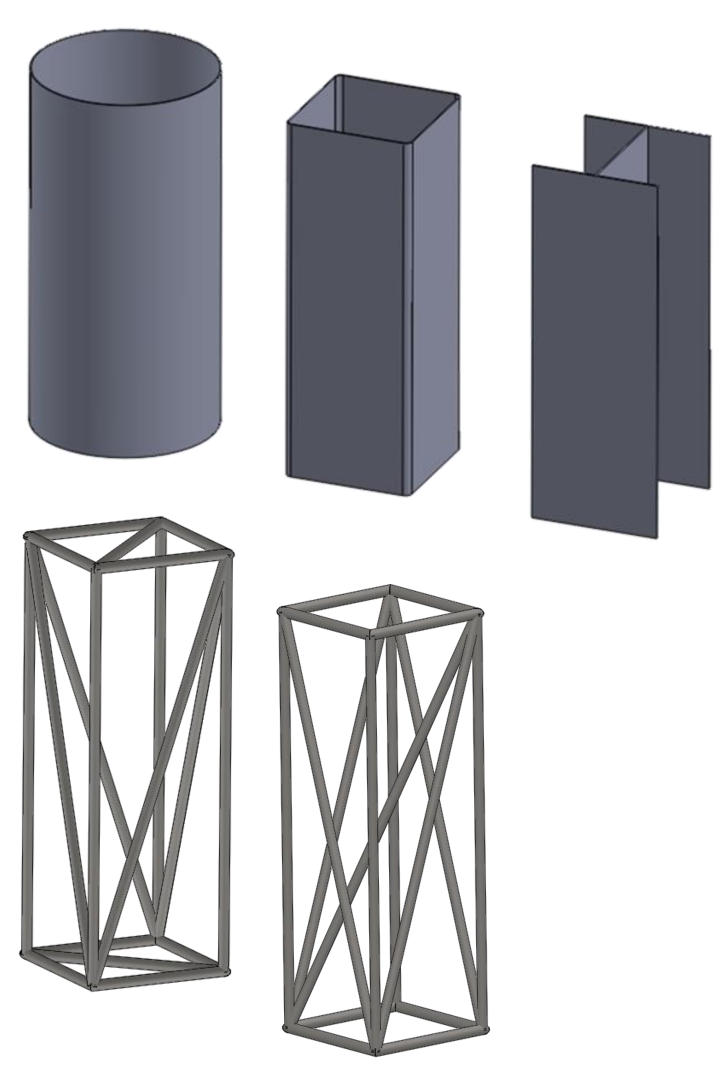
Baseline Structural Comparisons

Conditions:

L = 10-in long
Fit within a 5-in cylinder
All sized as 1/2-lb

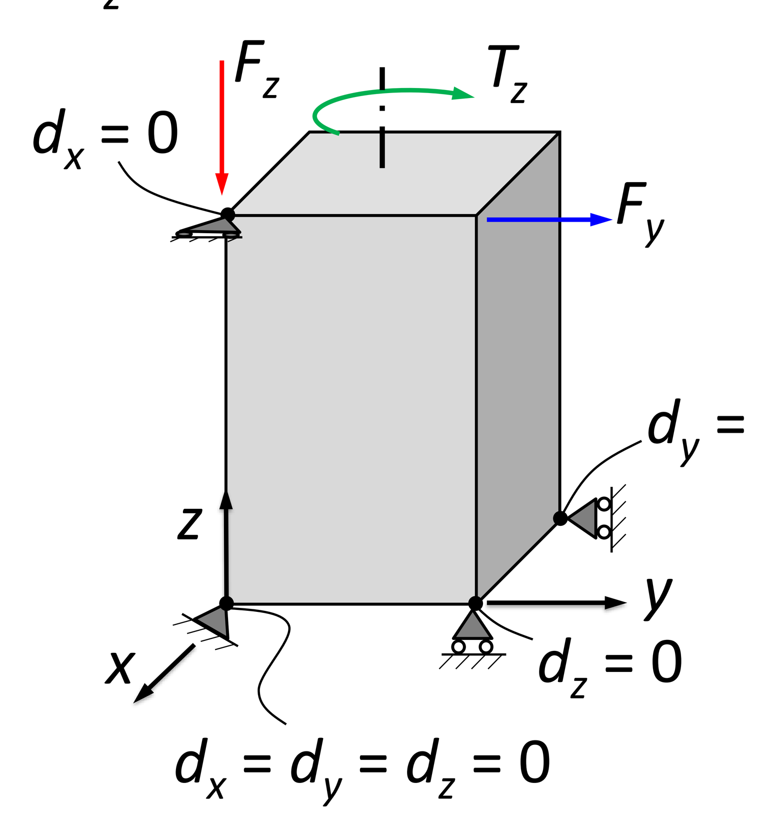


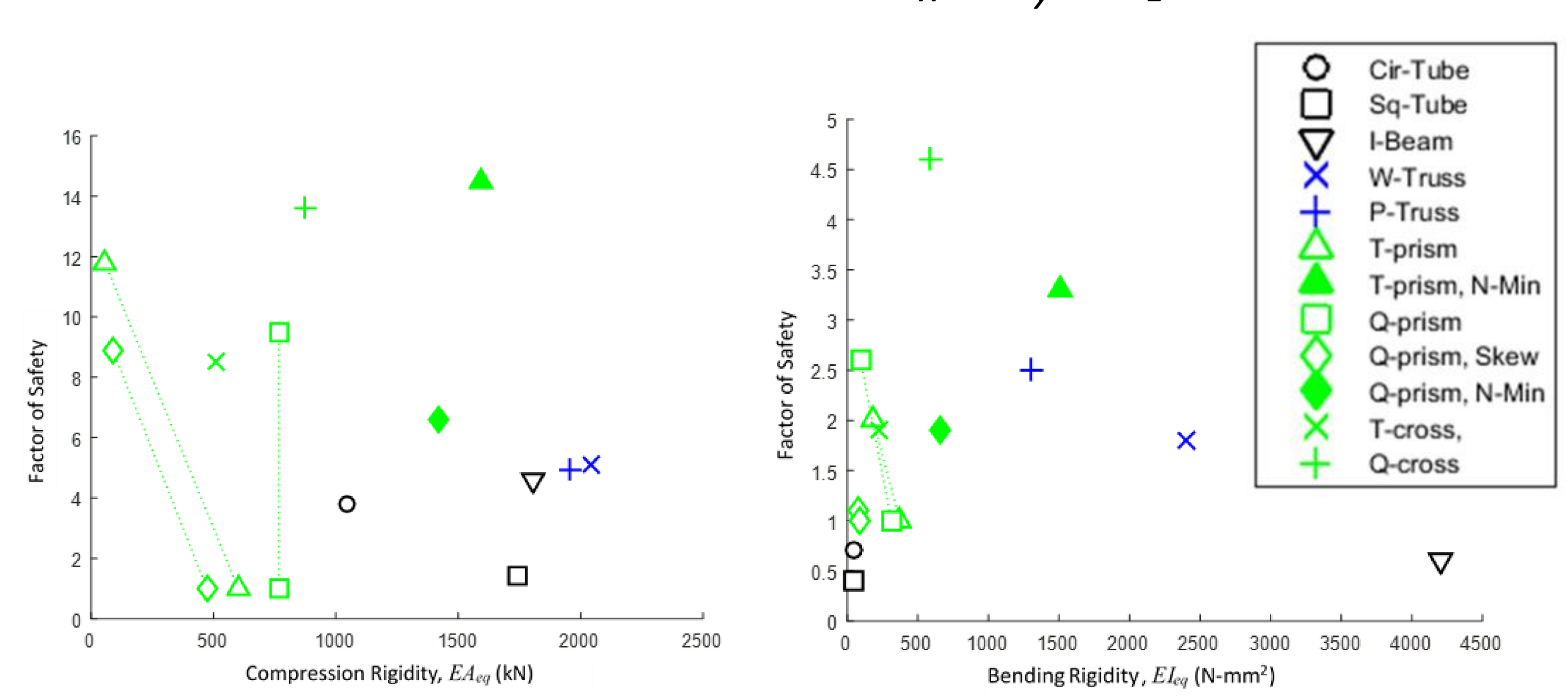
Test Structures:



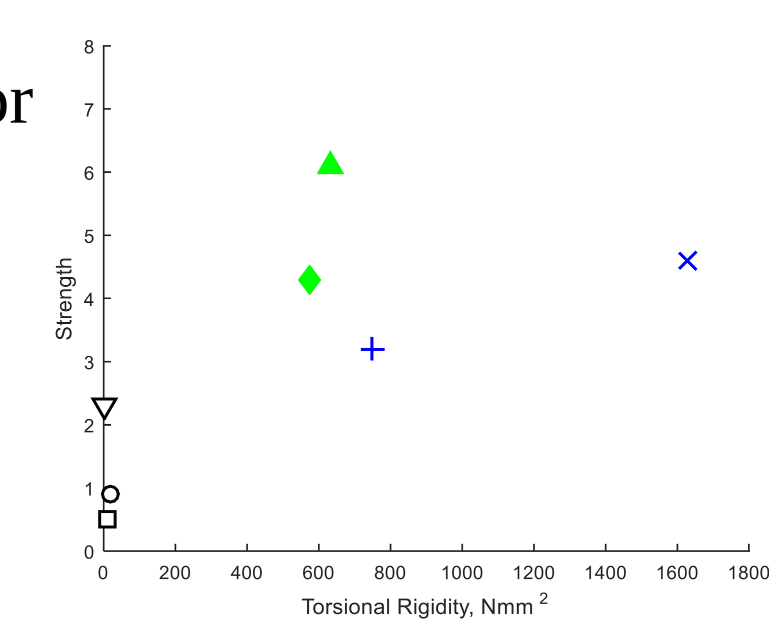
Loading:

F_z = 100 lb F_y = 100 lb
T_z = 250 in-lb





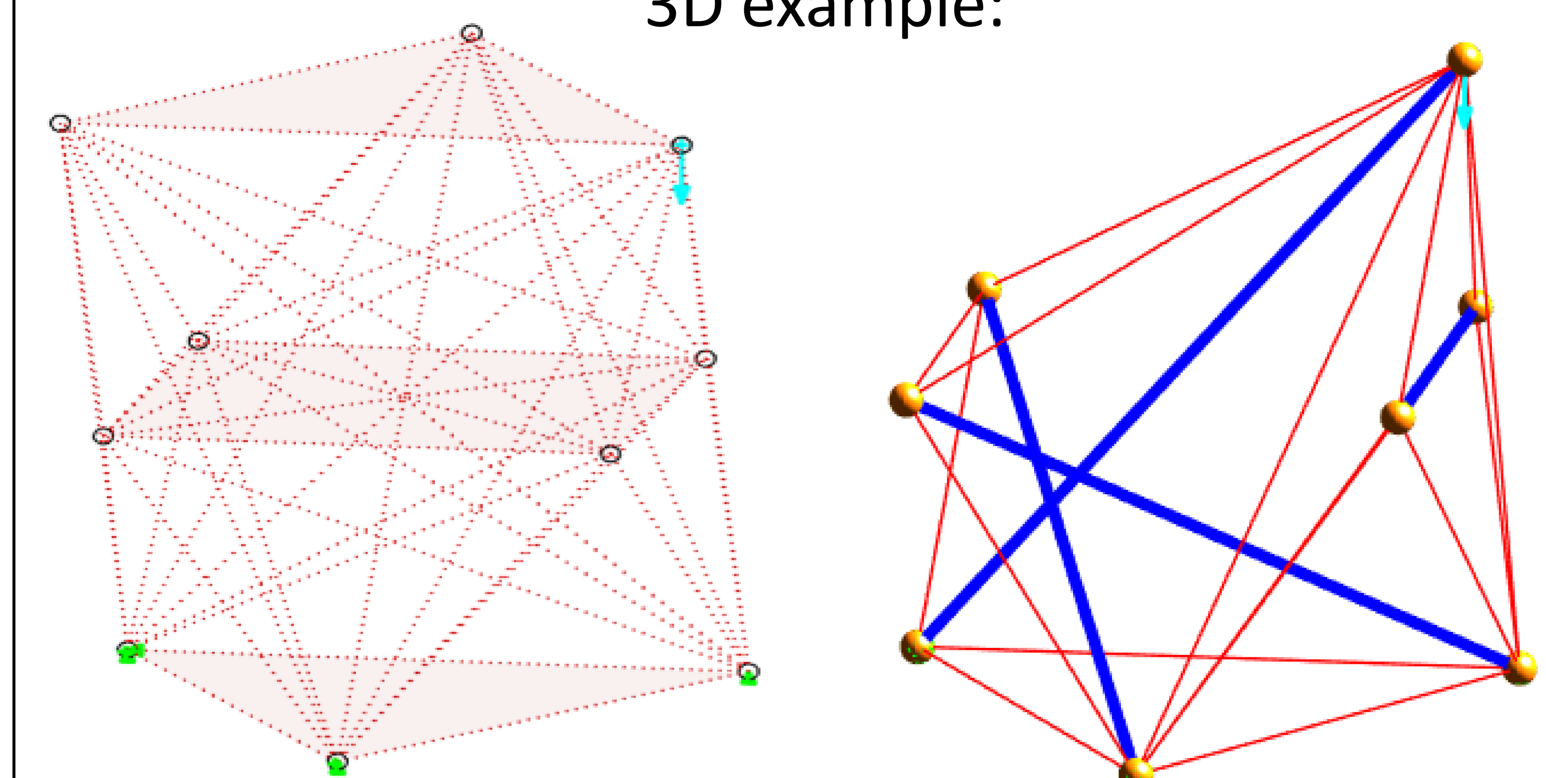
- The **trusses** are best for general purpose.
- The **non-minimal tensegrity** are comparable for all cases.



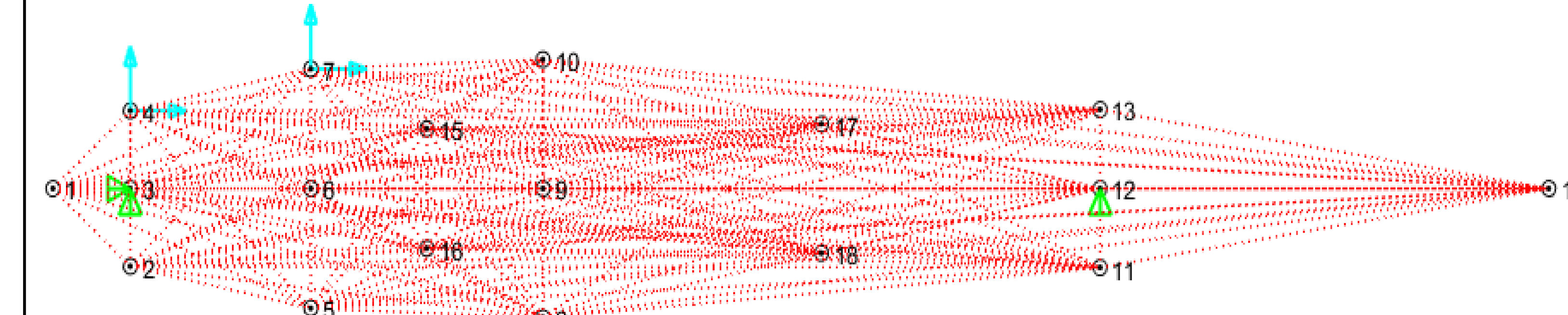
Topology Optimization

- Mixed integer linear program
- Minimize total weight while maintaining equilibrium during pre-tension and under external loading

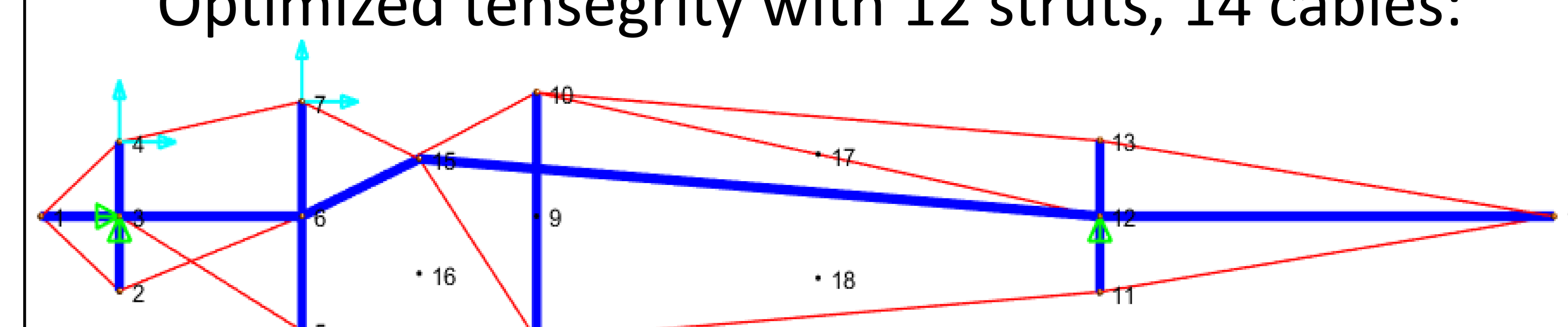
3D example:



Planar tensegrity wing ground structure:



Optimized tensegrity with 12 struts, 14 cables:



Ongoing and Future Work

- Produce a static 3D tensegrity aircraft wing design based upon optimization results ran on the Ohio Supercomputer Center
- Rigidity comparison between the conventional Vans RV-4 aircraft wing and the tensegrity aircraft wing under aerodynamic loading.
- Physical prototype of the tensegrity wing
- Investigating the morphing capabilities of tensegrity wing structures