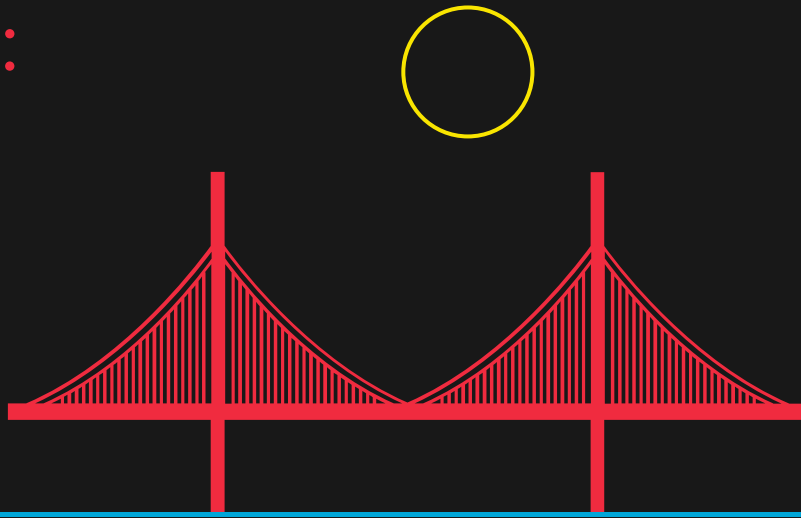
Projektwoche Angewandte Mathematik 2025

Designoptimierung oder: Wie konstruiert man eine Brücke?



Der kleine Amerikaner

Teil 2


Coca-Cola


Coca-Cola


Coca-Cola


Coca-Cola

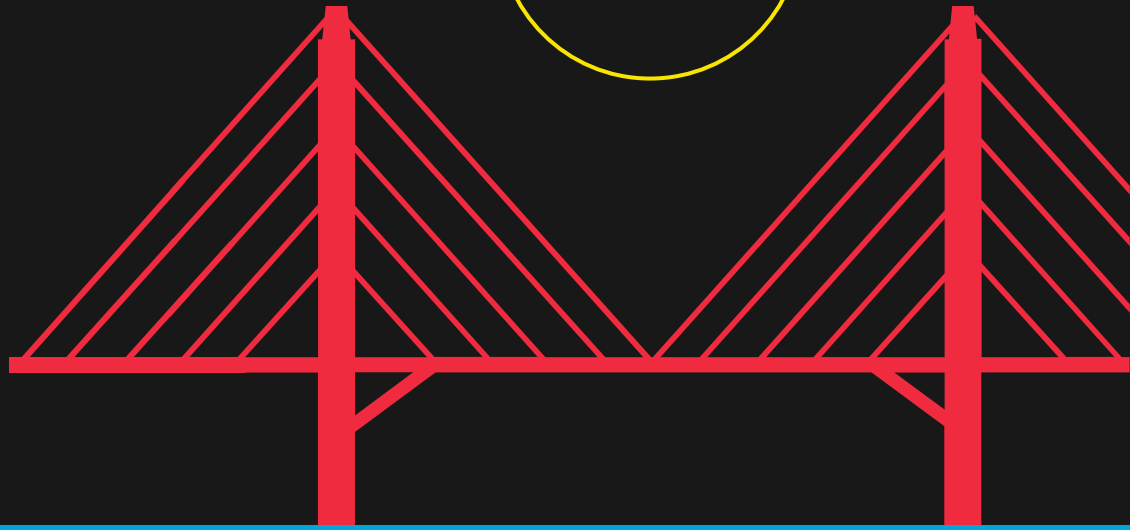

Coca-Cola

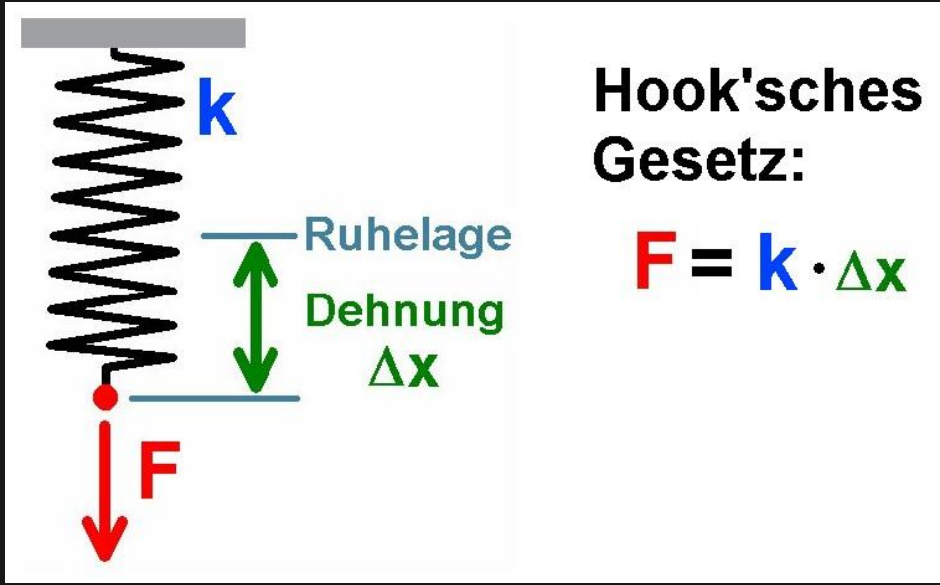

???????
Coca-Cola

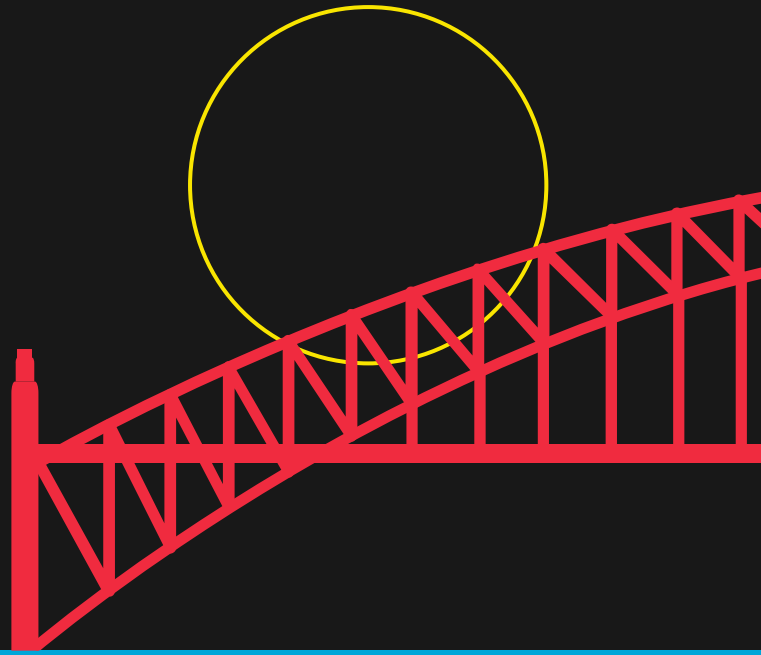
Modelierung einer Brücke

01

Welche Kräfte wirken auf eine Brücke?




k
Ruhelage
Dehnung
Δx
F
Hook'sches
Gesetz:
F = k · Δx



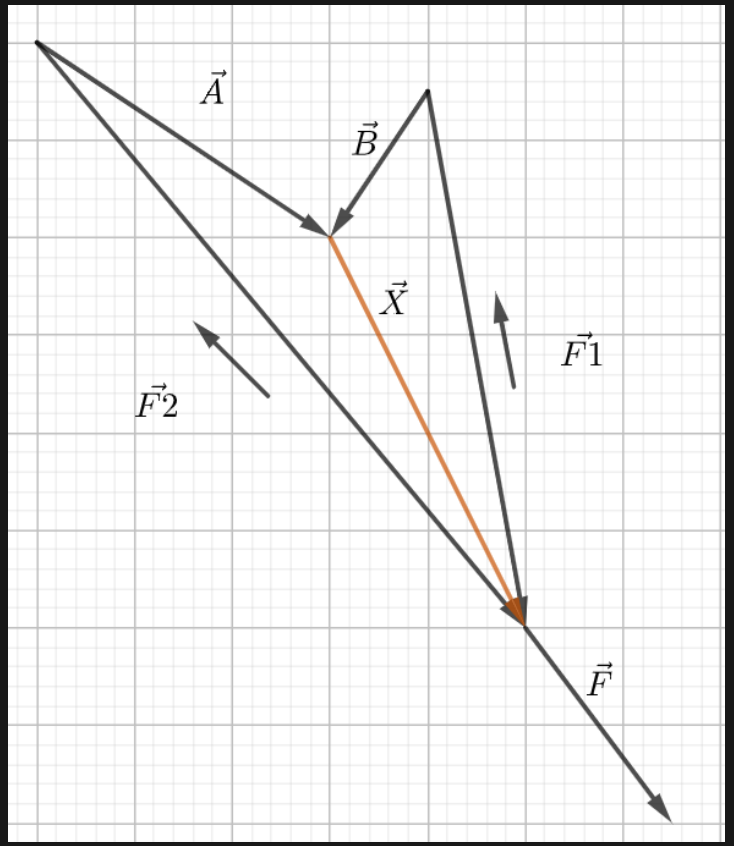
$$\vec{F} + \overrightarrow{F_1} + \overrightarrow{F_2} = 0$$

$$\overrightarrow{F_1} = -k_1 \cdot \Delta l_1 \cdot \frac{\vec{A} + \vec{X}}{|\vec{A} + \vec{X}|}$$

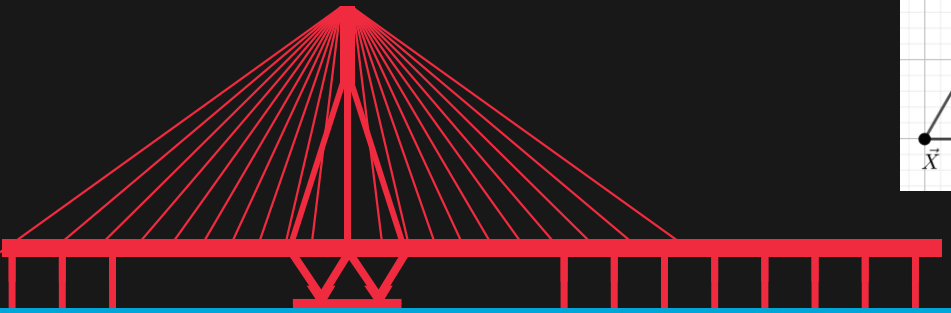
$$\Delta l_1 = \frac{\vec{A} \cdot \vec{X}}{|\vec{A}|}$$

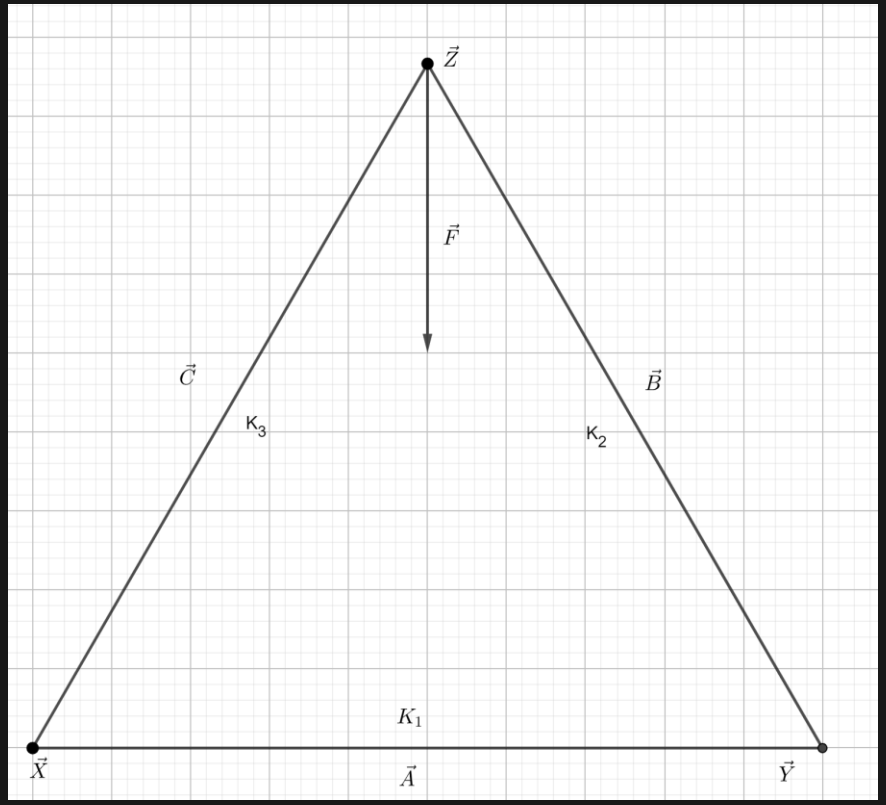
$$\overrightarrow{F_2} = -k_2 \cdot \Delta l_2 \cdot \frac{\vec{B} + \vec{X}}{|\vec{B} + \vec{X}|}$$

$$\Delta l_2 = \frac{\vec{B} \cdot \vec{X}}{|\vec{B}|}$$

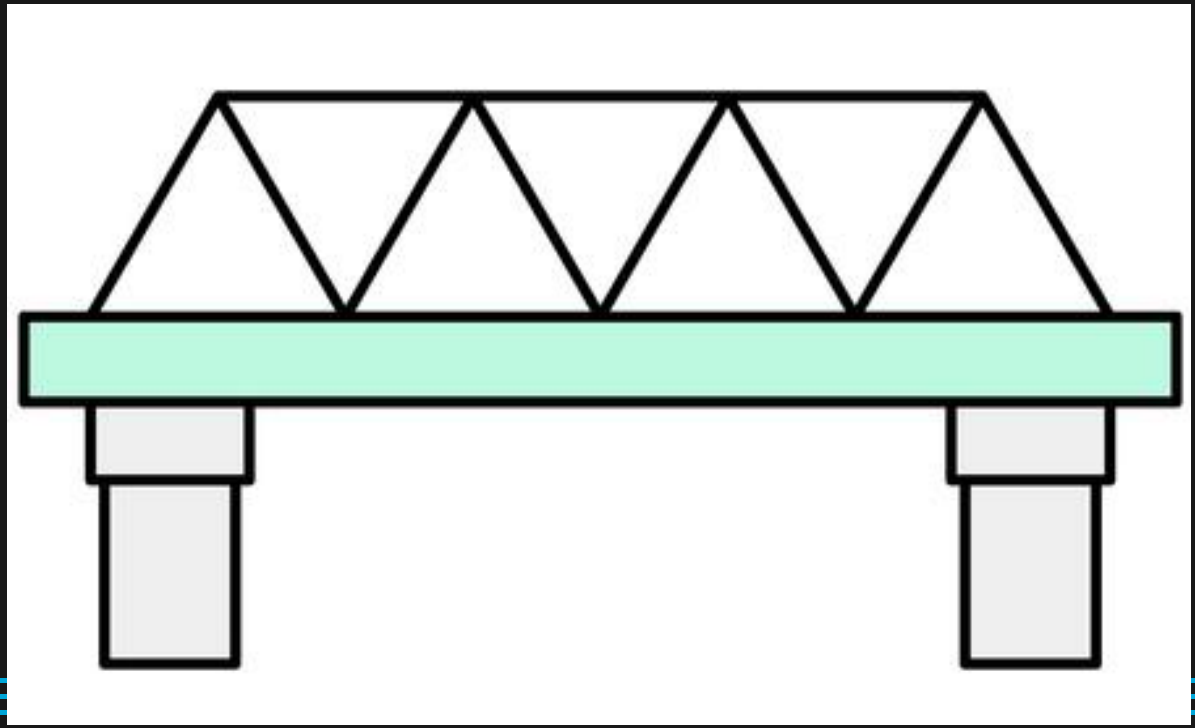


- Kräftegleichgewicht in jedem Punkt
- Lineares Gleichungssystem
- Lösbar durch Matrizen





Das ist eine Brücke.



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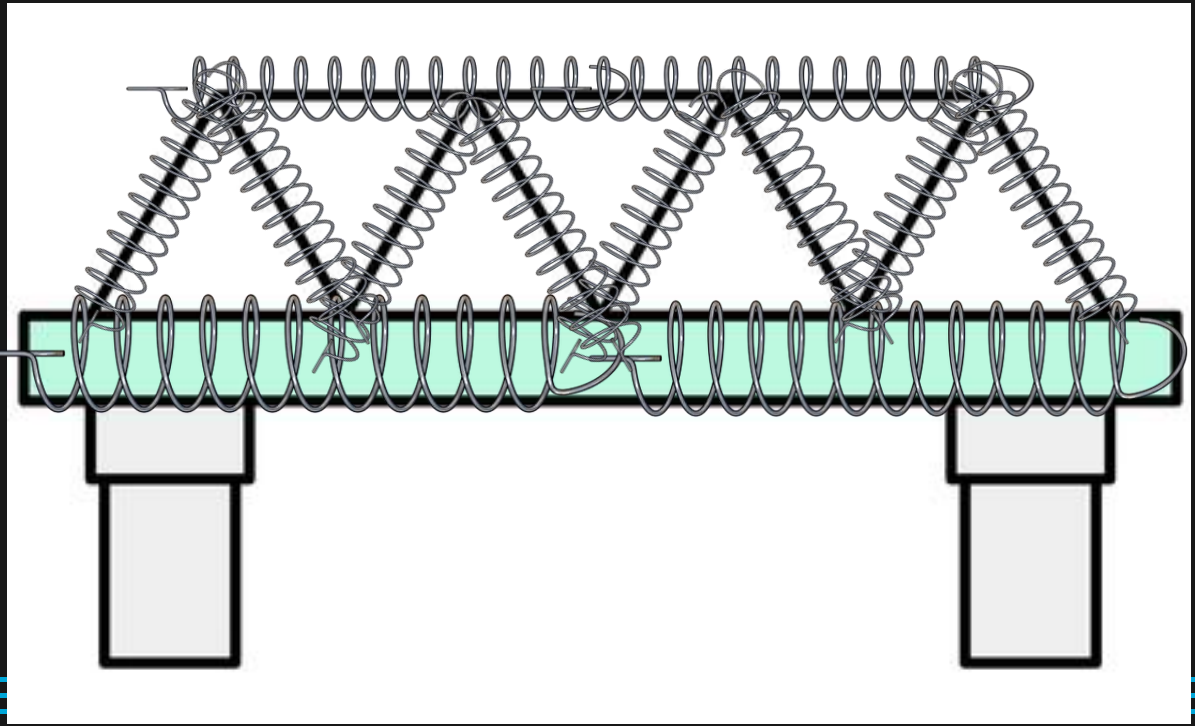
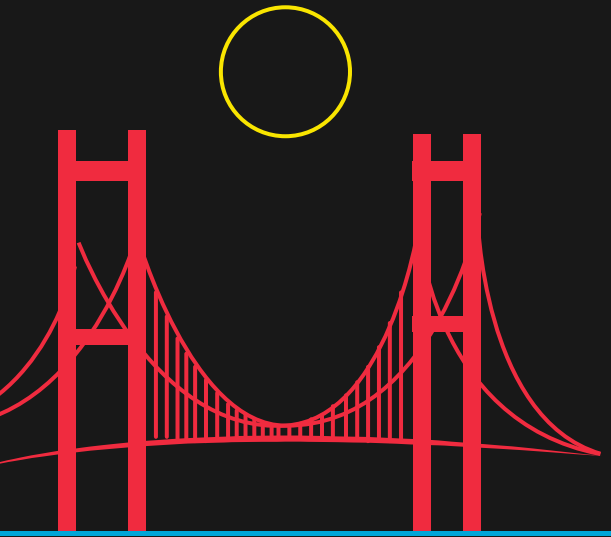


02

Designoptimierung

Welches Design ist am robustesten?

Was kann optimiert werden?



Topologie

Allgemeine Struktur

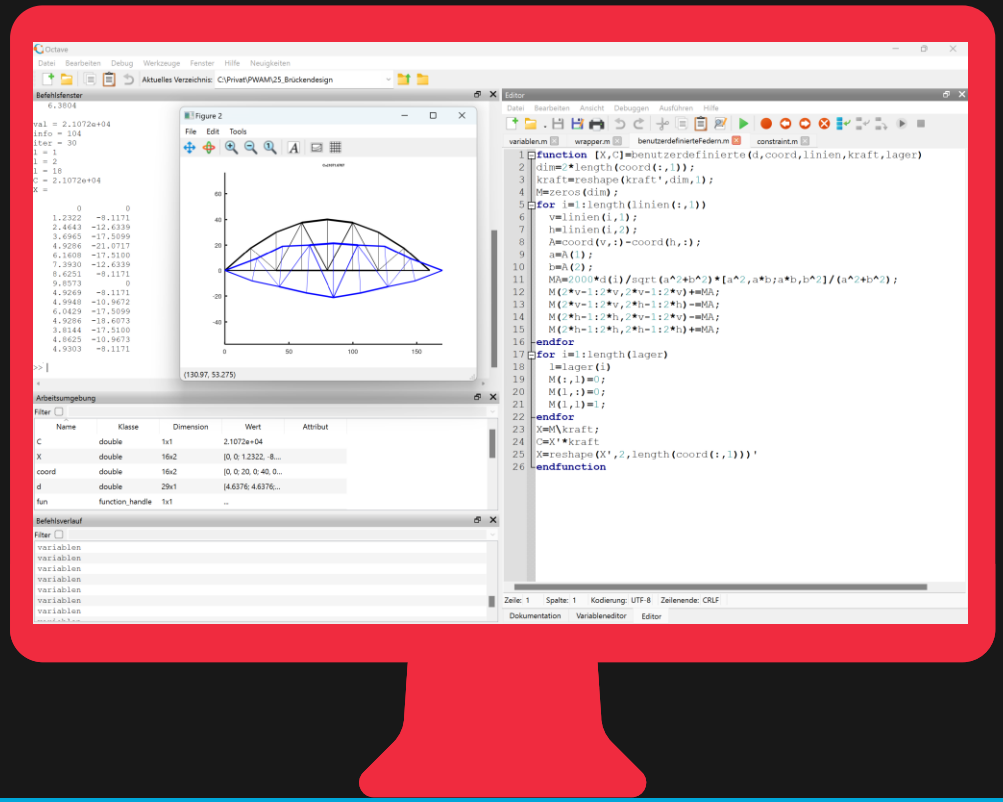
Dicke der Stäbe

-> Federkonstante

Position der Knoten

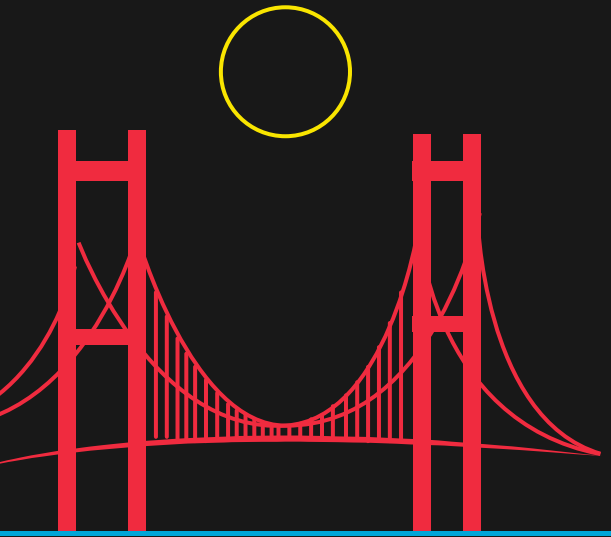
X- und y-Koordinaten

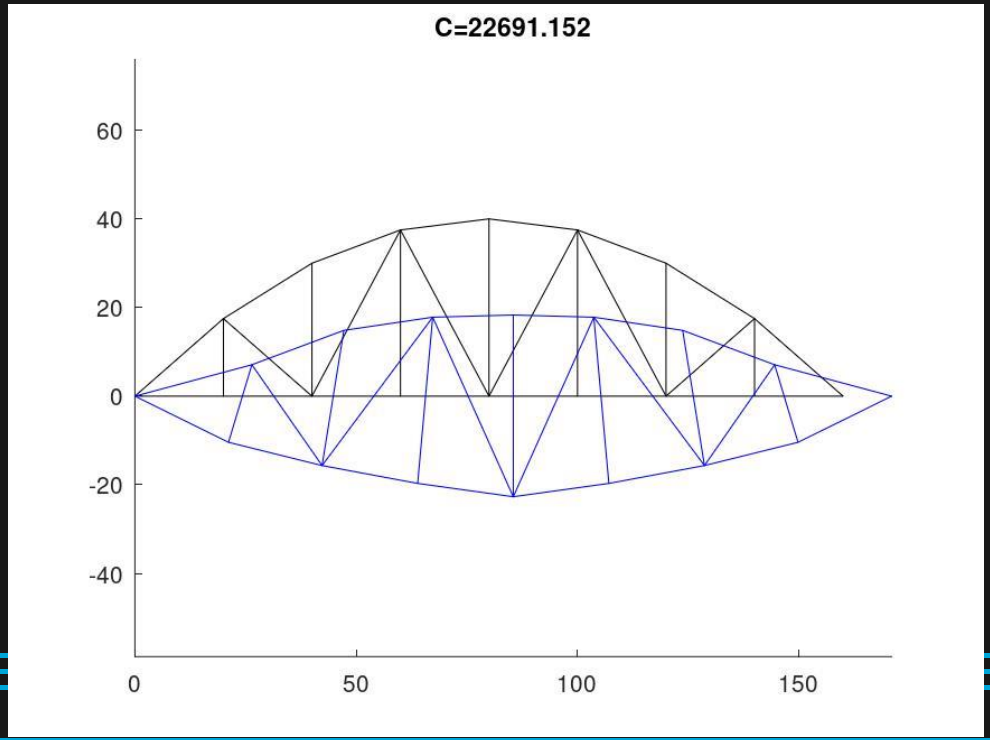
Optimierung mit Octave



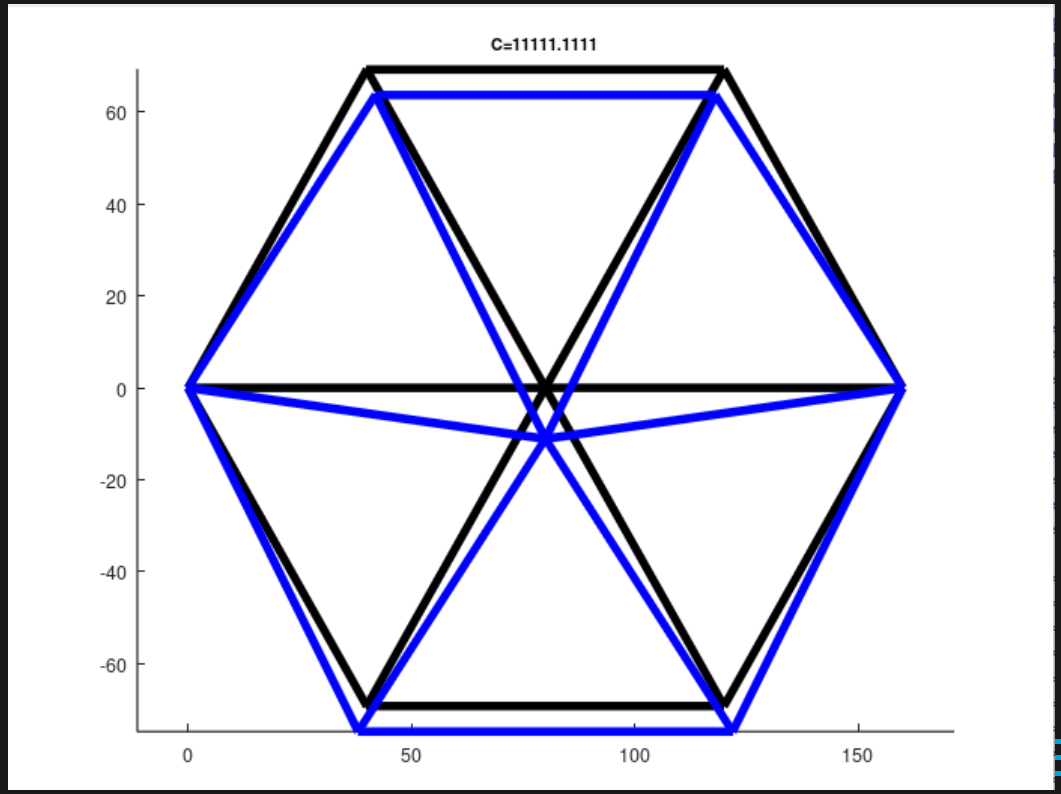
Ziel: möglichst kleines C

C=22mm

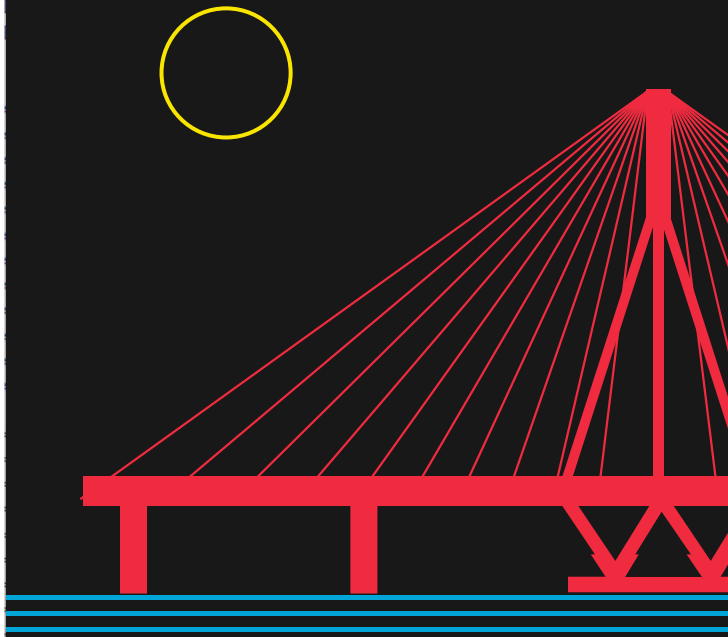




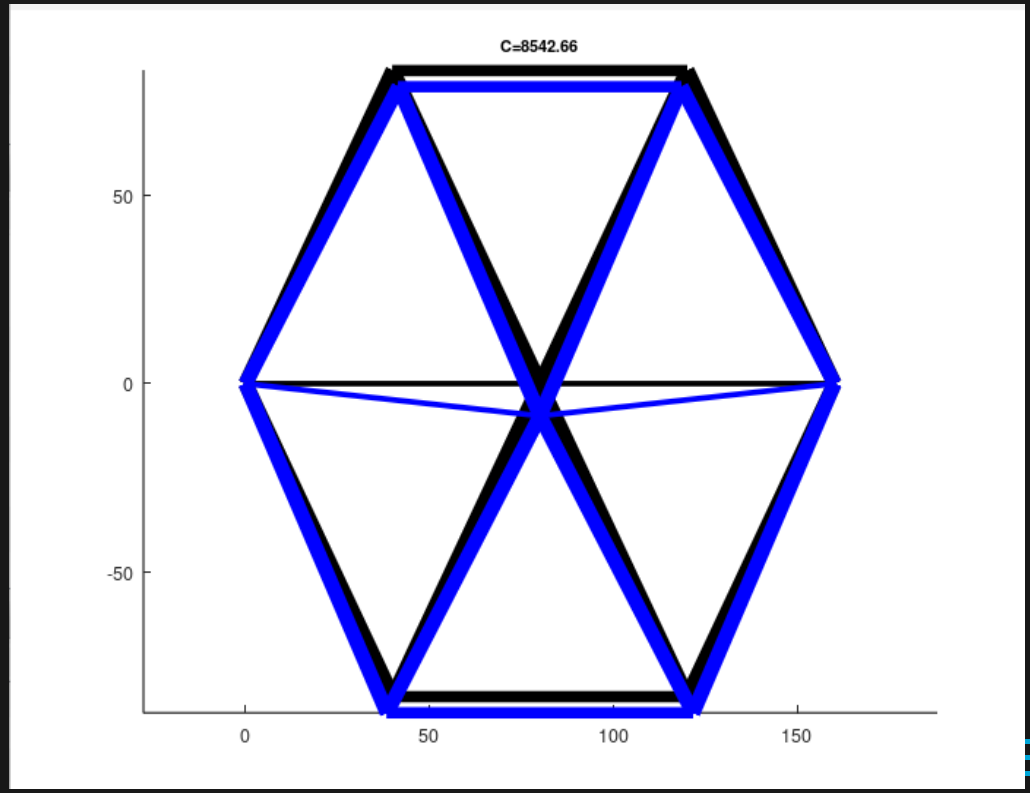
Mögliche Topologie



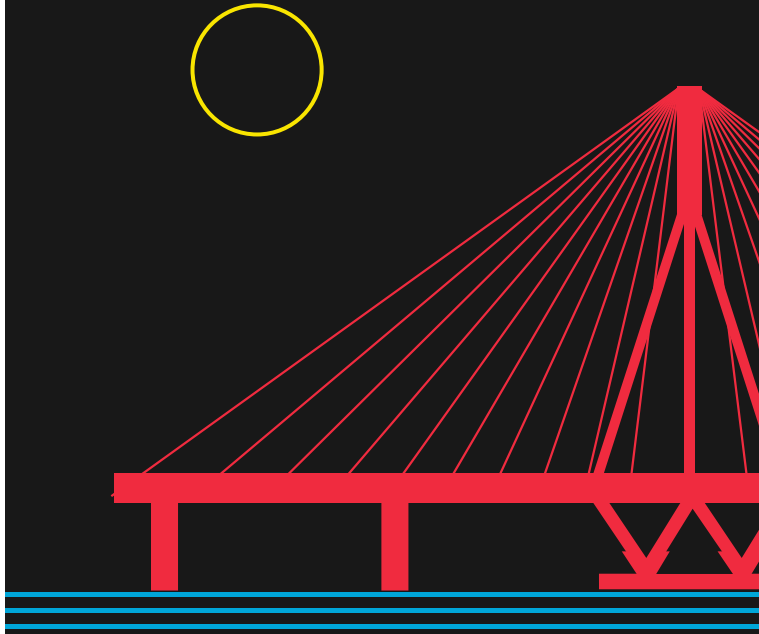
C=11mm



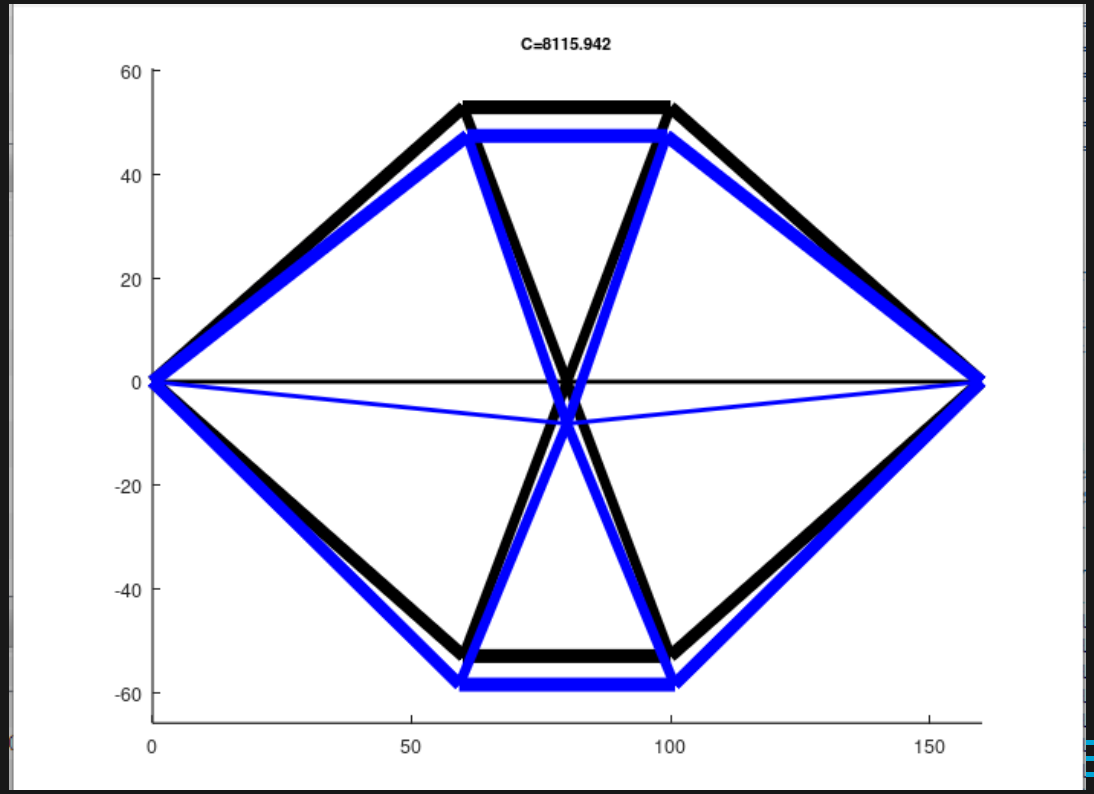
Stabdicken und y-Koordinaten optimiert



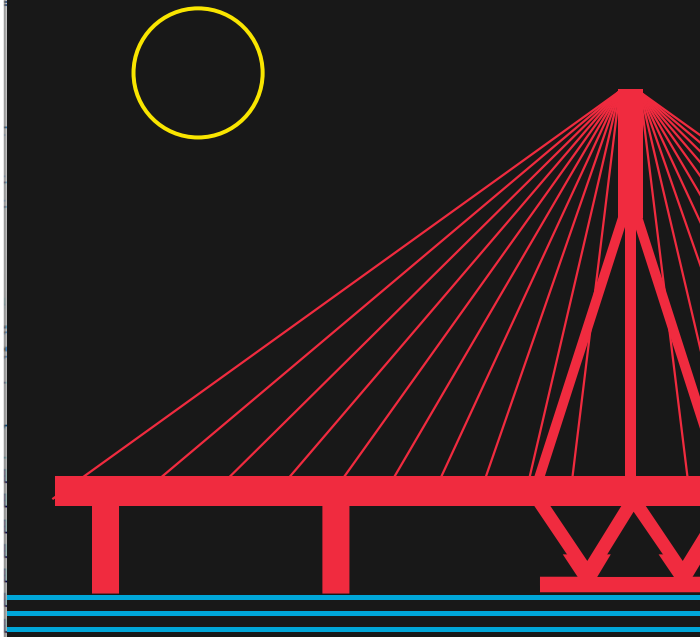
C=8,5mm



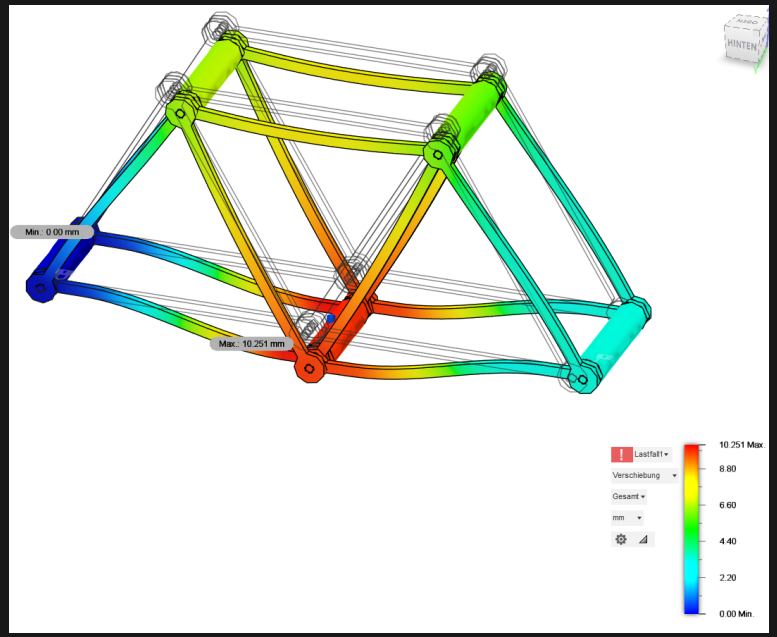
x-Koordinaten optimiert

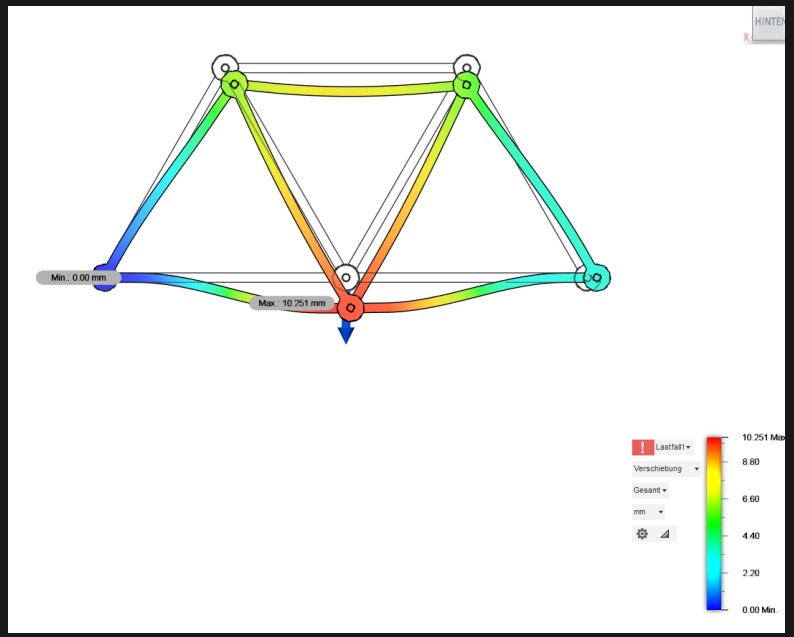


C=8,1mm

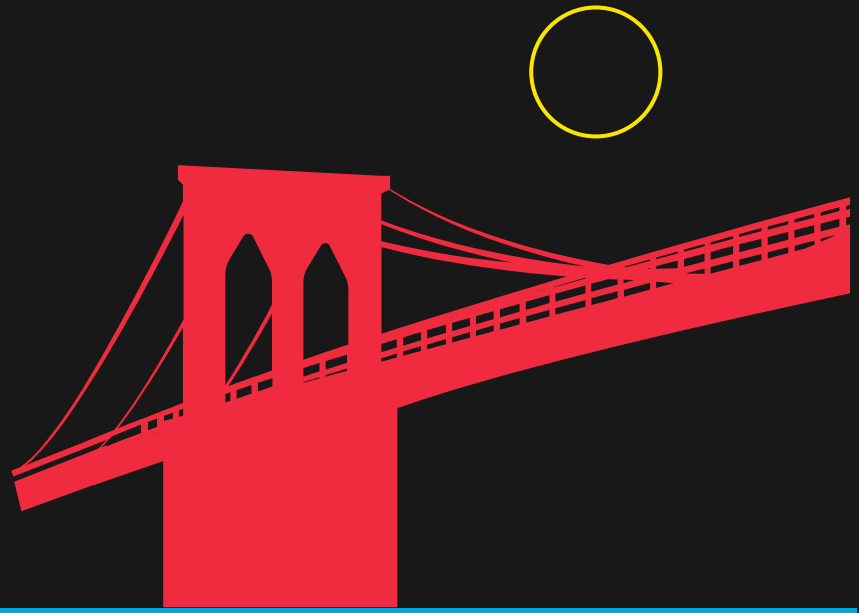


Darstellung im CAD





Ergebnis

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