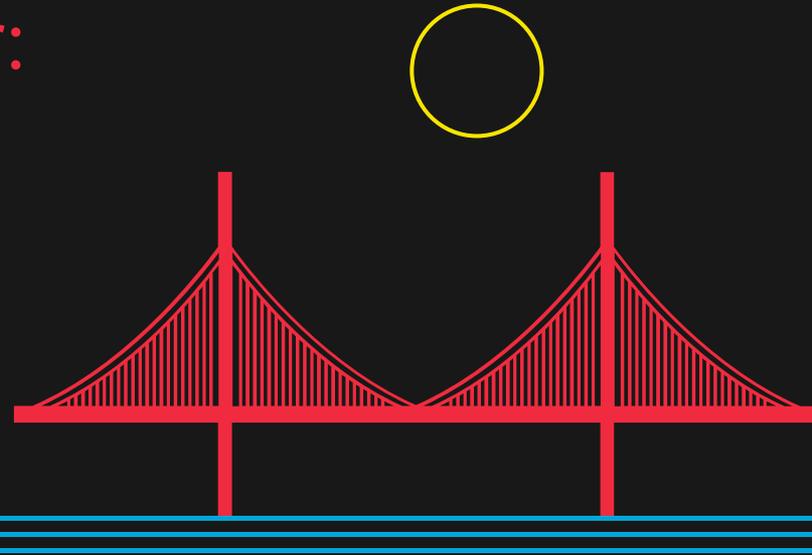


Designoptimierung oder: Wie konstruiert man eine Brücke?

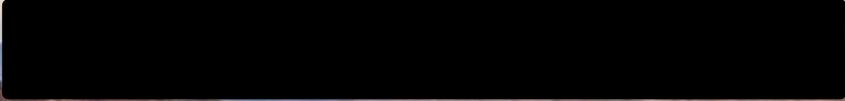


Der kleine Amerikaner



Teil 2















???????

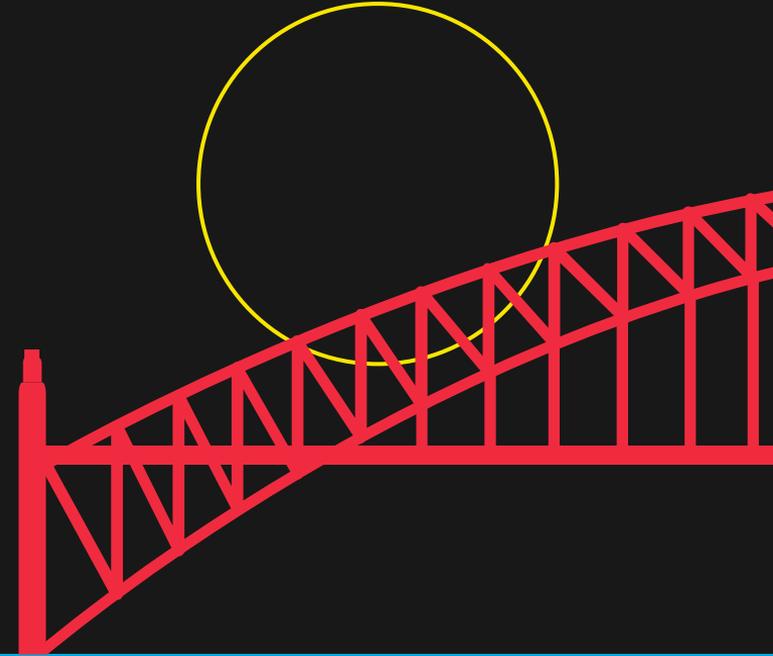
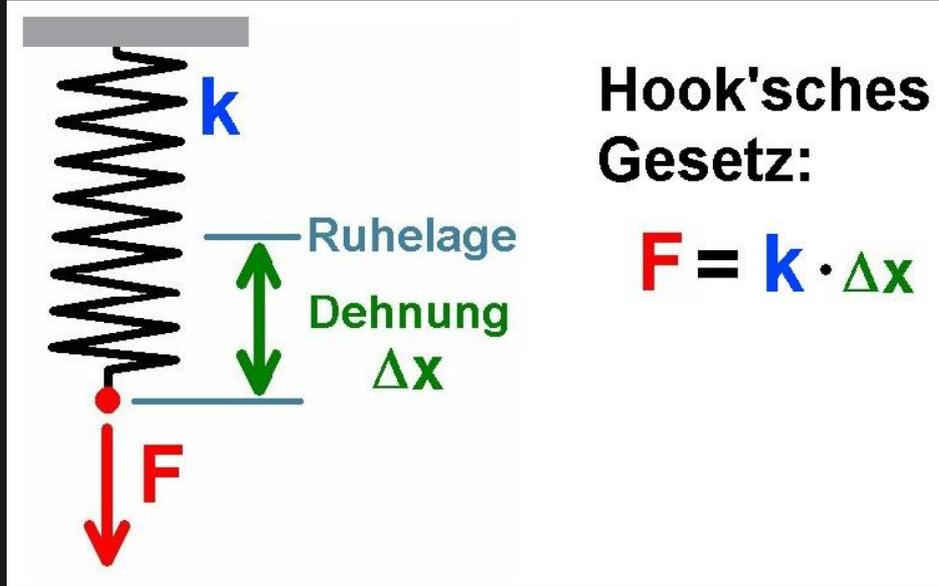


Modellierung einer Brücke

Welche Kräfte wirken auf eine
Brücke?

01





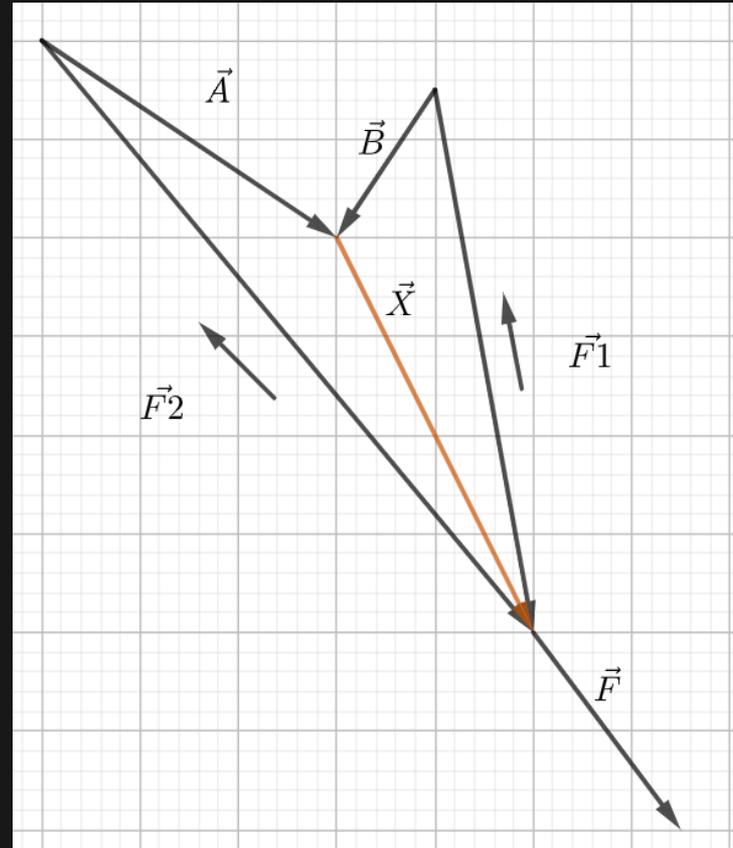
$$\vec{F} + \vec{F}_1 + \vec{F}_2 = 0$$

$$\vec{F}_1 = -k_1 \cdot \Delta l_1 \cdot \frac{\vec{A} + \vec{X}}{|\vec{A} + \vec{X}|}$$

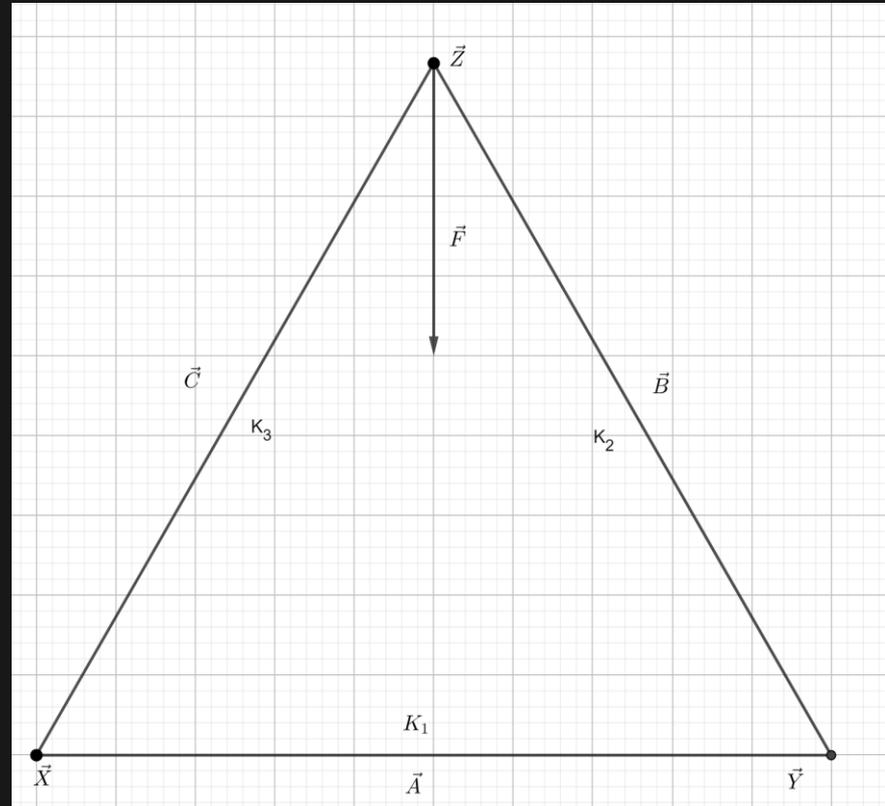
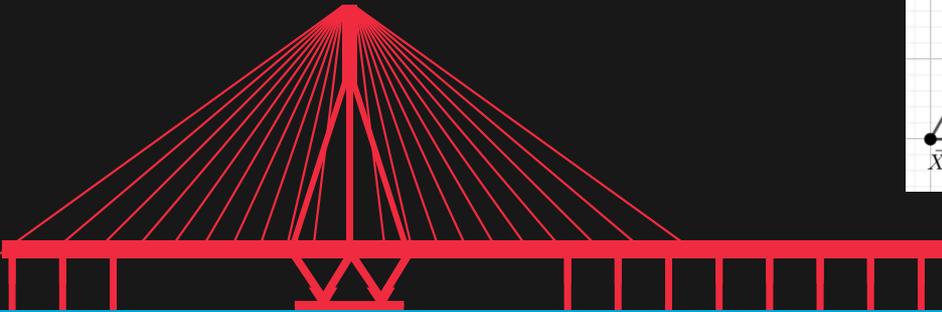
$$\Delta l_1 = \frac{\vec{A} \cdot \vec{X}}{|\vec{A}|}$$

$$\vec{F}_2 = -k_2 \cdot \Delta l_2 \cdot \frac{\vec{B} + \vec{X}}{|\vec{B} + \vec{X}|}$$

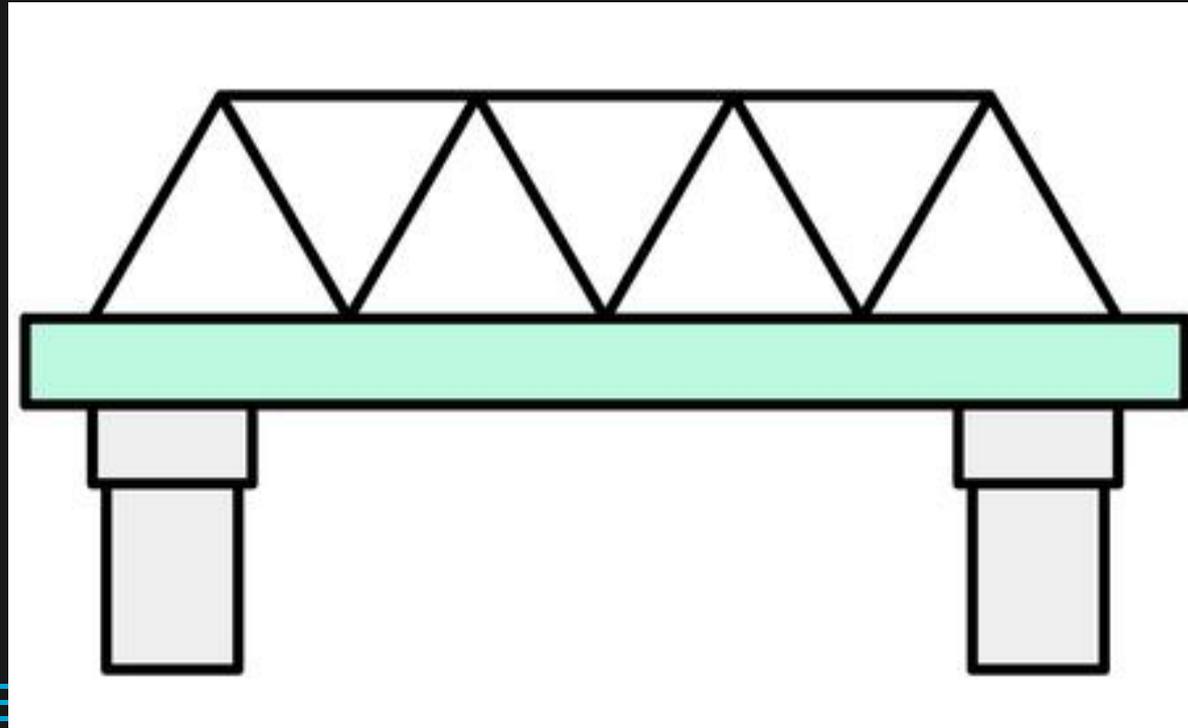
$$\Delta l_2 = \frac{\vec{B} \cdot \vec{X}}{|\vec{B}|}$$



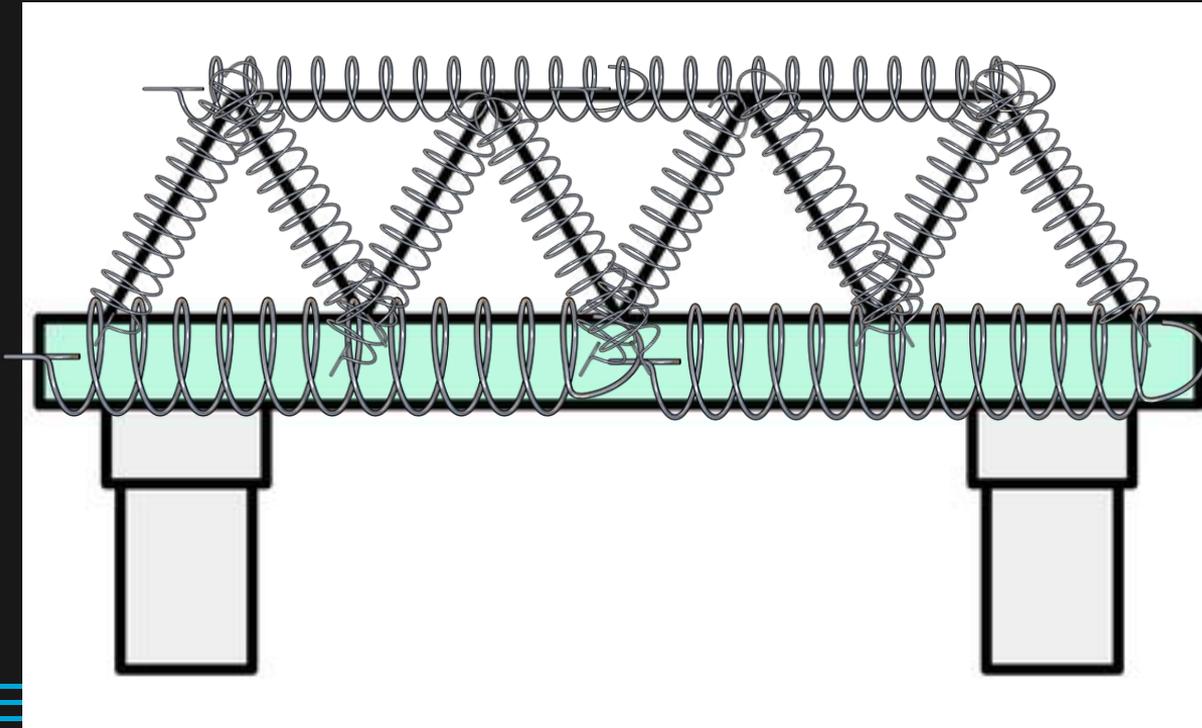
- Kräftegleichgewicht in jedem Punkt
- Lineares Gleichungssystem
- Lösbar durch Matrizen



Das ist eine Brücke.



Das ist eine Brücke.





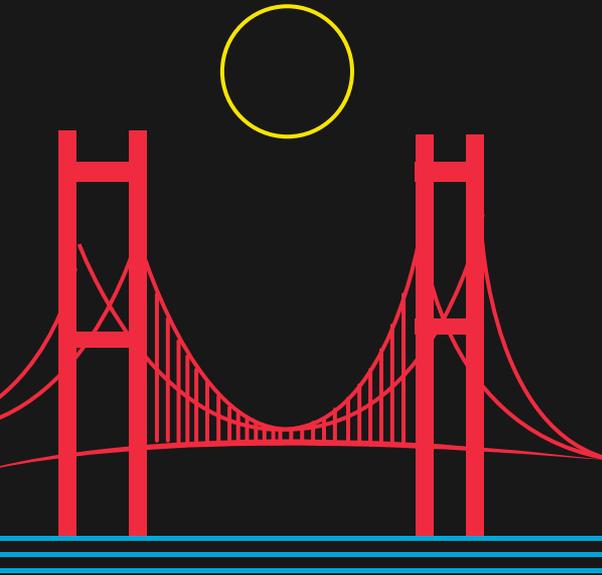
02

Designoptimierung

Welches Design ist am
robustesten?



Was kann optimiert werden?



Topologie

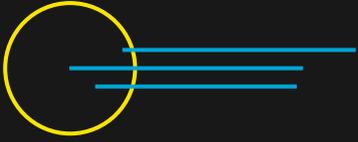
Allgemeine Struktur

Dicke der Stäbe

-> Federkonstante

Position der Knoten

X- und y-Koordinaten



Optimierung mit Octave

The screenshot displays the Octave environment with the following components:

- Command Window:** Shows the execution of a script with the following output:

```
val = 2.1072e+04
info = 104
iter = 30
l = 1
l = 2
l = 18
C = 2.1072e+04
X =
    0         0
    1.2322  -8.1171
    2.4643  -12.6339
    3.6965  -17.5099
    4.9286  -21.9717
    6.1608  -17.5160
    7.3930  -12.6339
    8.6251  -8.1171
    9.8573   0
    4.9286  -8.1171
    4.9481  -10.9472
    6.0429  -17.5099
    4.9286  -18.4073
    3.0144  -17.5160
    4.8625  -10.9473
    4.9303  -8.1171
```
- Figure Window:** Displays a plot of a truss structure with a blue force distribution and a black displacement curve. The x-axis ranges from 0 to 190, and the y-axis ranges from -40 to 60. A coordinate point (130.97, 53.275) is highlighted.
- Editor Window:** Contains the following MATLAB/Octave code:

```
function [X,C]=benutzerspezifiziertefinierte(d,coord,linien,kraft,lager)
1 dim=length(coord(:,1));
2 kraft=reshape(kraft',dim,1);
3 M=zeros(dim);
4
5 for i=length(linien(:,1))
6     v=linien(i,1);
7     h=linien(i,2);
8     A=coord(v,:)-coord(h,:);
9     a=A(1,:);
10    b=A(2,:);
11    M(a*b*a')/sqrt(a^2+b^2)*[a^2,a*b;a*b,b^2]/(a^2+b^2);
12    M(*v-1:2*v,2*h-1:2*h)+=M(a);
13    M(*v-1:2*v,2*h-1:2*h)+=M(b);
14    M(*h-1:2*h,2*v-1:2*v)+=M(a);
15    M(*h-1:2*h,2*v-1:2*v)+=M(b);
16
17 for i=length(lager)
18     l=lager(i)
19     M(i,1)=0;
20     M(i,2)=0;
21     M(i,1)=1;
22
23 endfor
24 C=X'*kraft;
25 X=reshape(X',2,length(coord(:,1)))
26 endfunction
```
- Workspace Window:** Shows a table of variables:

Name	Klasse	Dimension	Wert	Attribut
C	double	1x1	2.1072e+04	
X	double	16x2	[0 0; 1.2322; 4...	
coord	double	16x2	[0 0; 20 0; 40 0...	
d	double	29x1	[4.6376; 4.6376...	
fun	function_handle	1x1	...	

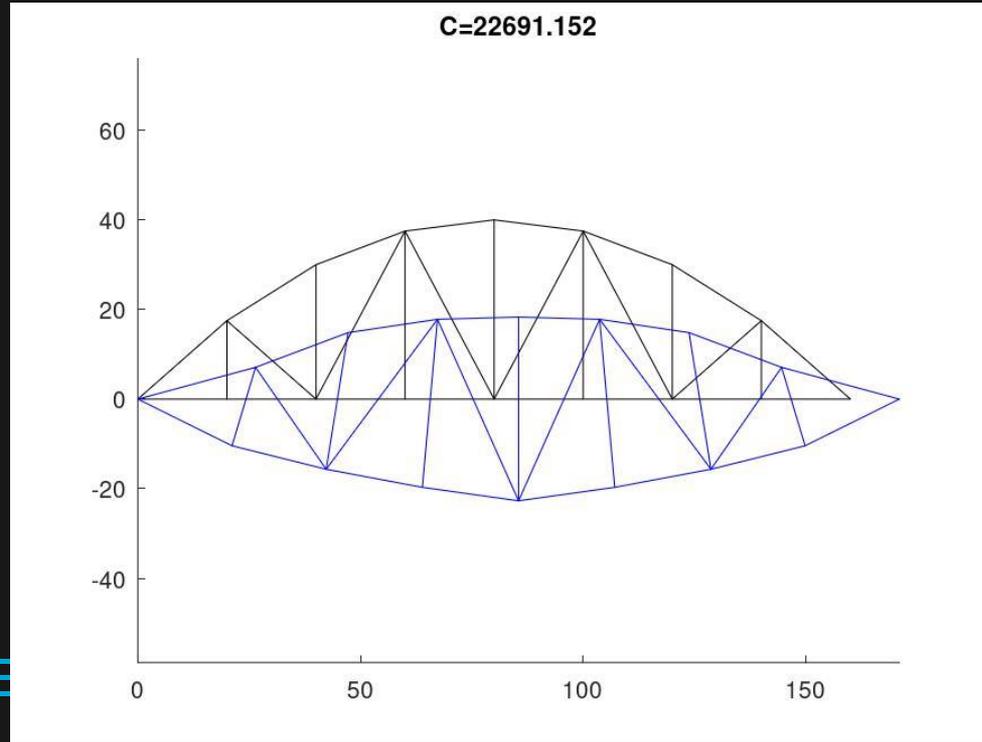
At the bottom of the editor, the status bar indicates: Zeile: 1 Spalte: 1 Kodierung: UTF-8 Zeilenende: CRLF



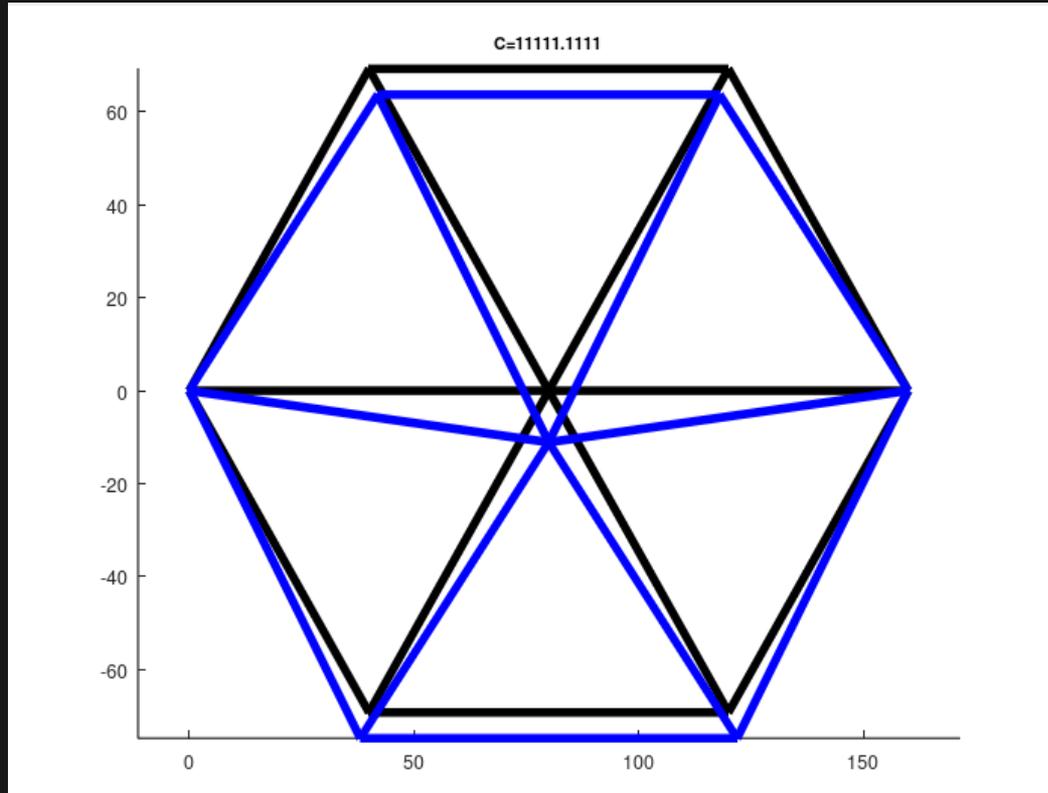


Ziel: möglichst kleines C

C=22mm



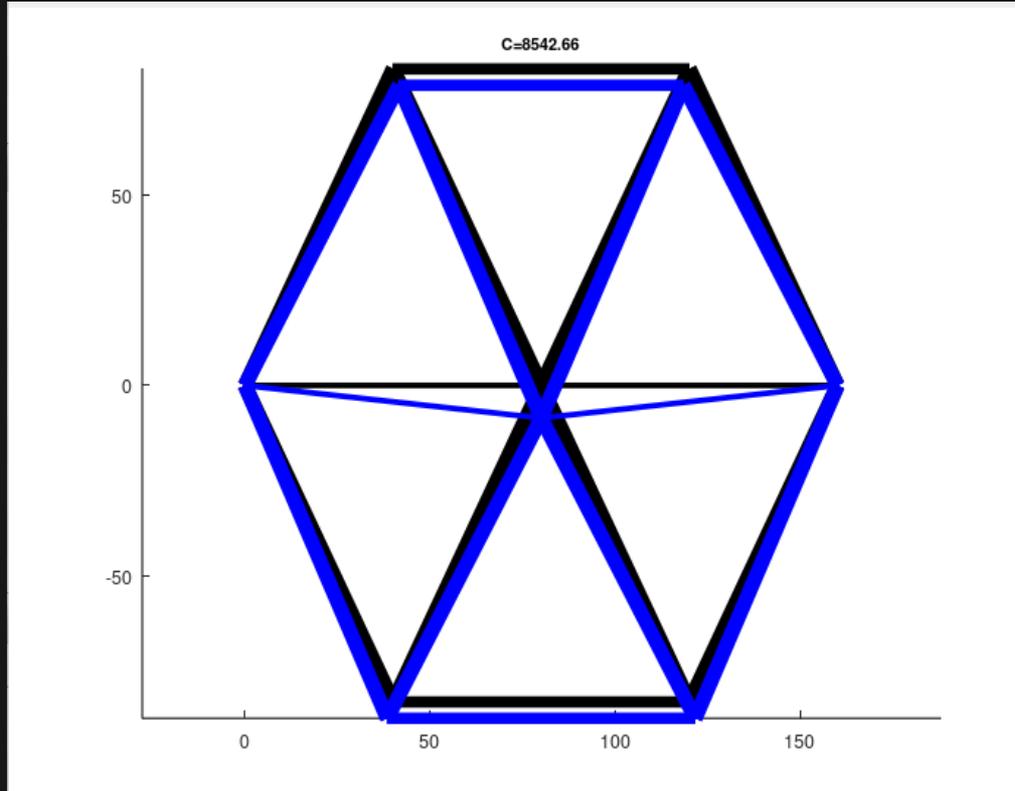
Mögliche Topologie



C=11mm



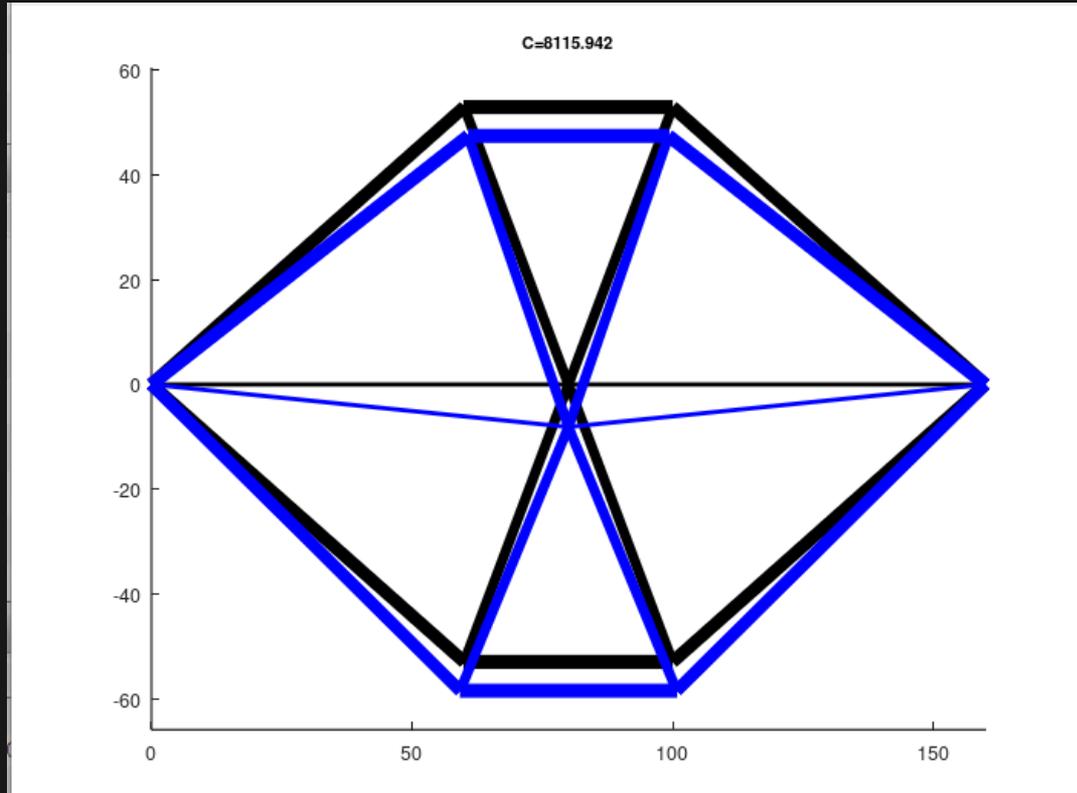
Stabdicken und y-Koordinaten optimiert



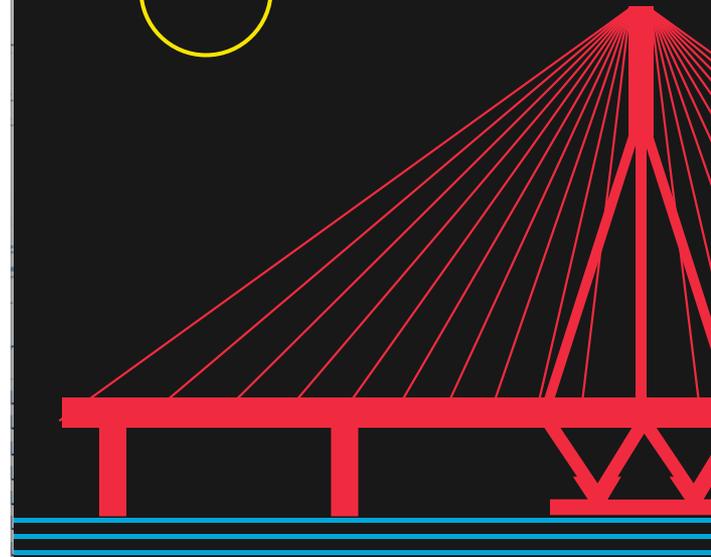
$C=8,5\text{mm}$



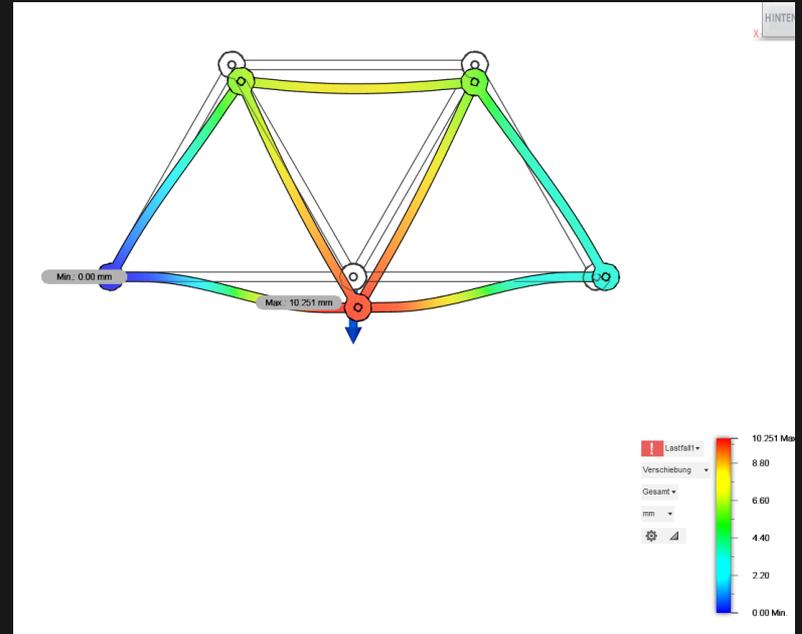
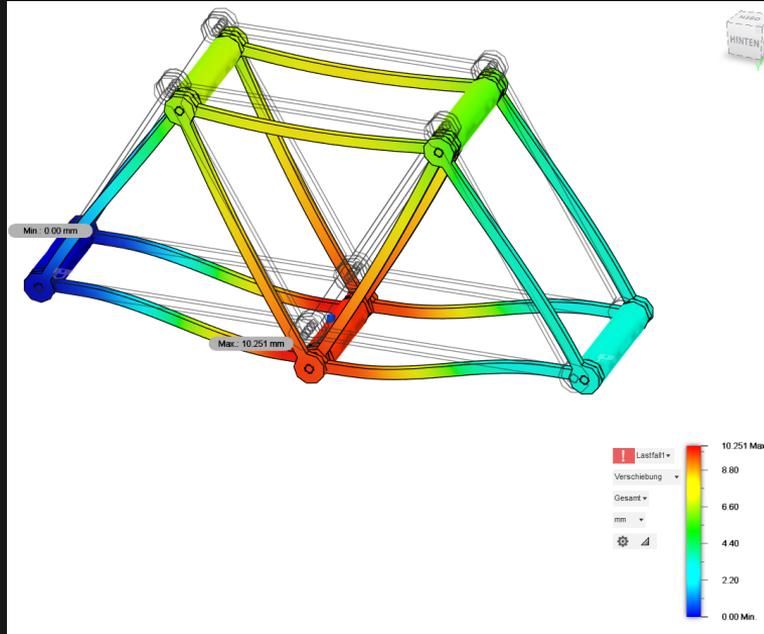
x-Koordinaten optimiert



C=8,1mm



Darstellung im CAD



Ergebnis



