Project 1: Sourdough Starter

ME 104: Mechanical Systems’s Design

Summary Report

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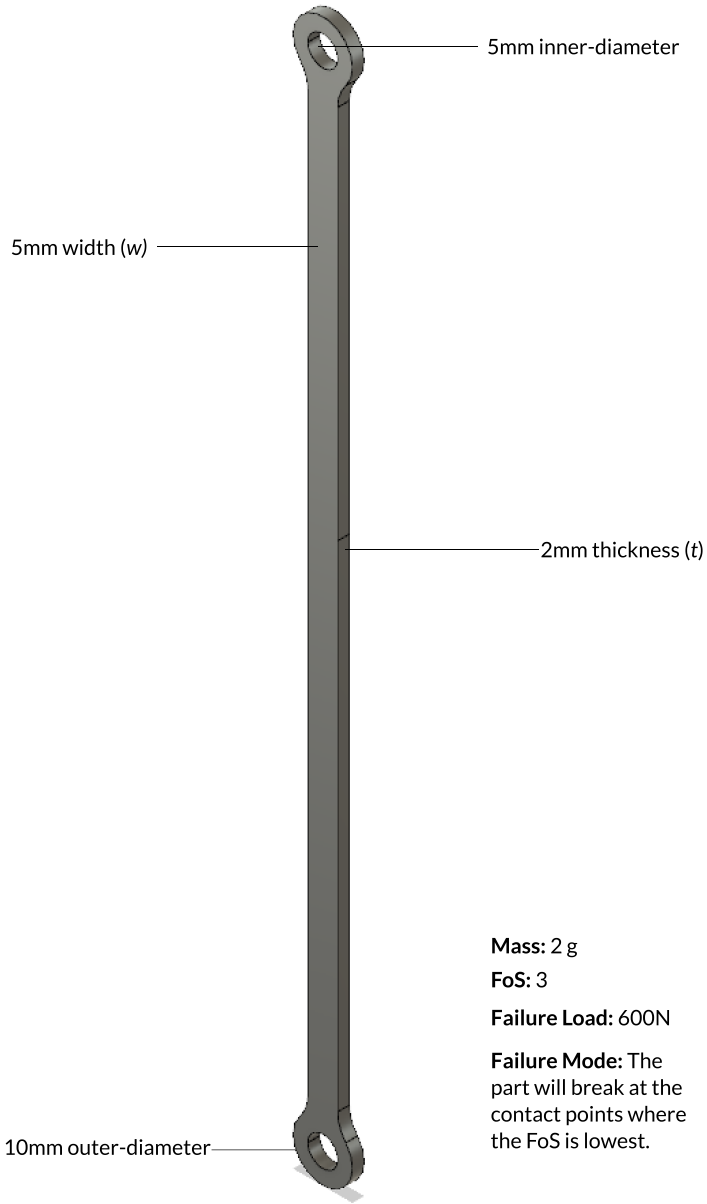
Description

The part presented was designed to be simple, lightweight, and have a uniform FoS.

The inner diameters measure 5mm to accommodate the width of the nylon cord. For uniformity, the shaft width was set equal to the inner diameters of the tie-off hoops. The outer diameter of 10mm was a natural choice given the design constraints under the simplest stress model. Adding 6mm fillets to the inside corners mitigates stress concentrations at the points where the hoops join with the shaft.

The part was designed with a Factor of Safety of 3 to improve the chances of a successful test given my limited access to materials. In the simplest model, axial stress will act uniformly along the length of the part, and thus the thickness t was calculated to be 2mm.

The part successfully endured well over 10 seconds under 200N load. Ultimately, FoS was not uniform throughout the part due to the simplicity of the models. More complex models could improve estimates by considering three-point bending at the contact points. Future iterations would reduce mass and factor of safety by reducing the width while increasing the thickness.

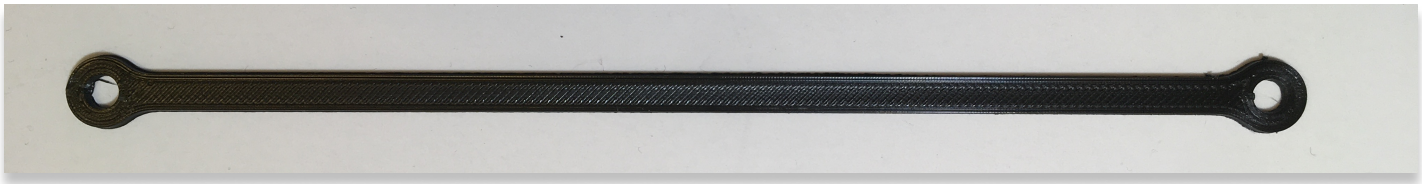


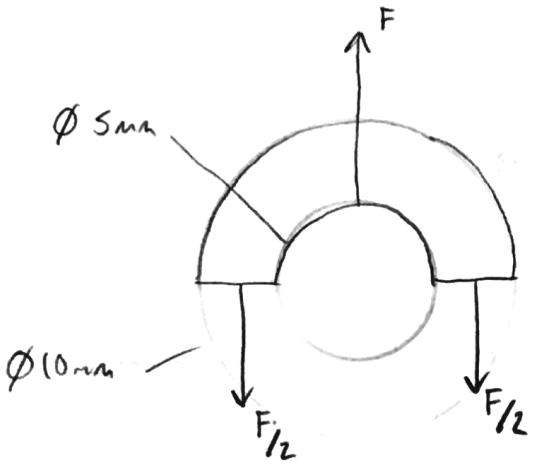
Mass: 2 g

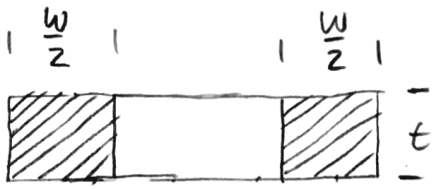
FoS: 3

Failure Load: 600N

Failure Mode: The part will break at the contact points where the FoS is lowest.







$\sigma = F/A$

$FoS = \frac{S_y}{\sigma}$

For $FoS = 3$

$F = 200\ N$

$w = 5.00\ mm$

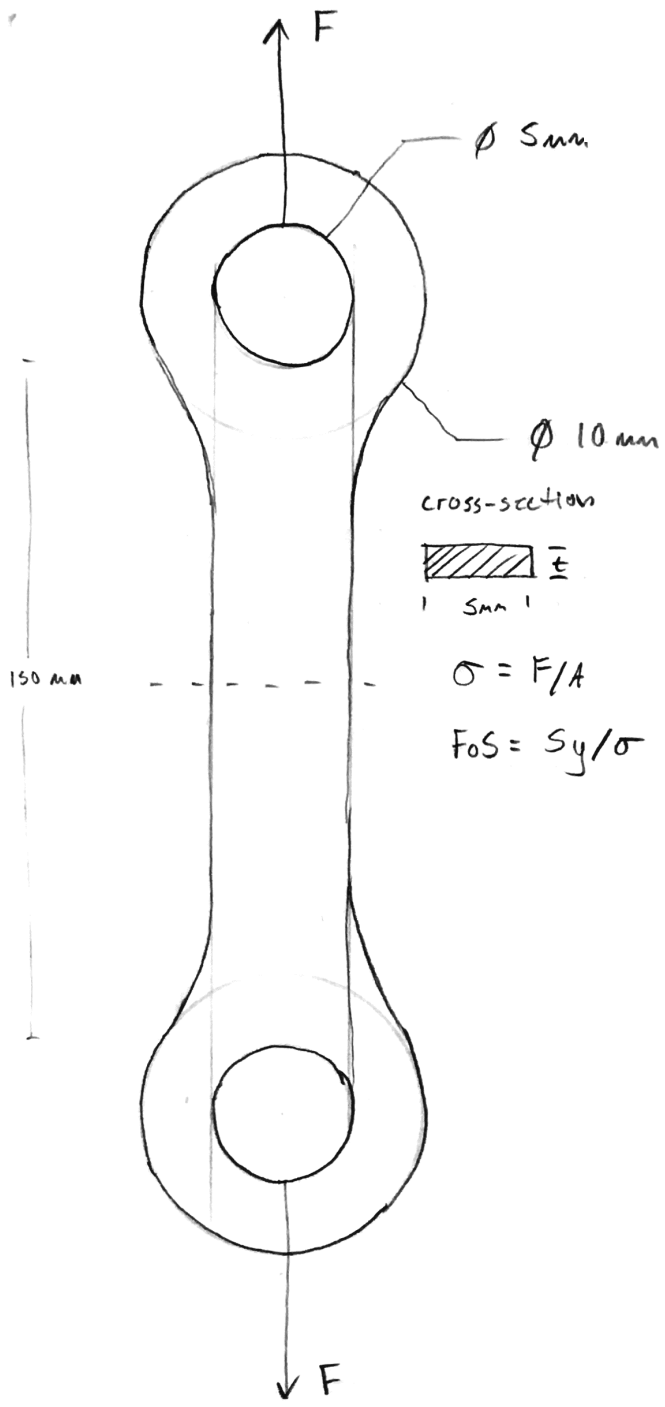
$\Rightarrow FoS = \frac{S_y A}{F}$

$2\left(\frac{w}{2}\right)t = \frac{FoS \cdot F}{S_y}$

$t = \frac{FoS \cdot F}{w \cdot S_y}$

$\therefore t = \frac{3 \cdot 200\,\cancel{N}}{5(10^{-3})\,\cancel{m}\,(60)(10^6)\,N/\cancel{m^2}}$

$t = 2\ mm$



$\sigma = F/A$

$FoS = S_y/\sigma$

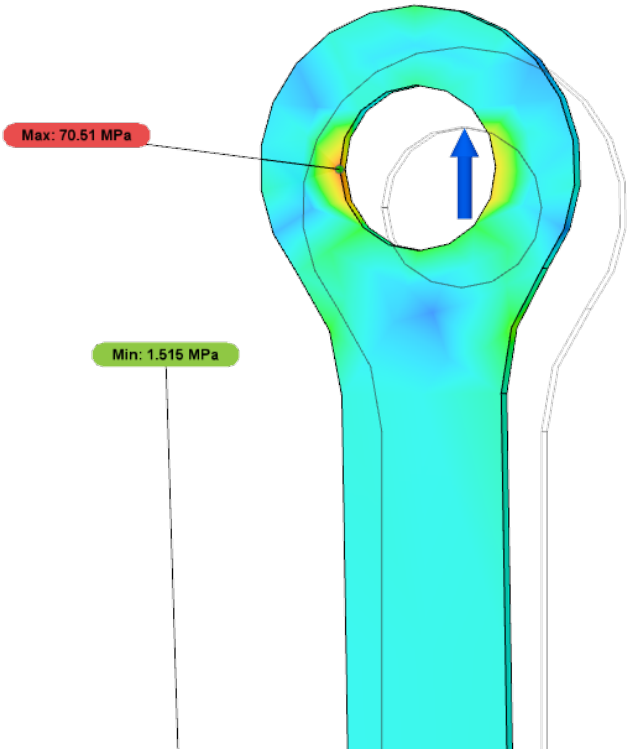
Estimates:

$\sigma = \frac{F}{A} = \frac{200}{(2)(5)(10^{-3})(10^{-3})}\ \frac{N}{m^2}$

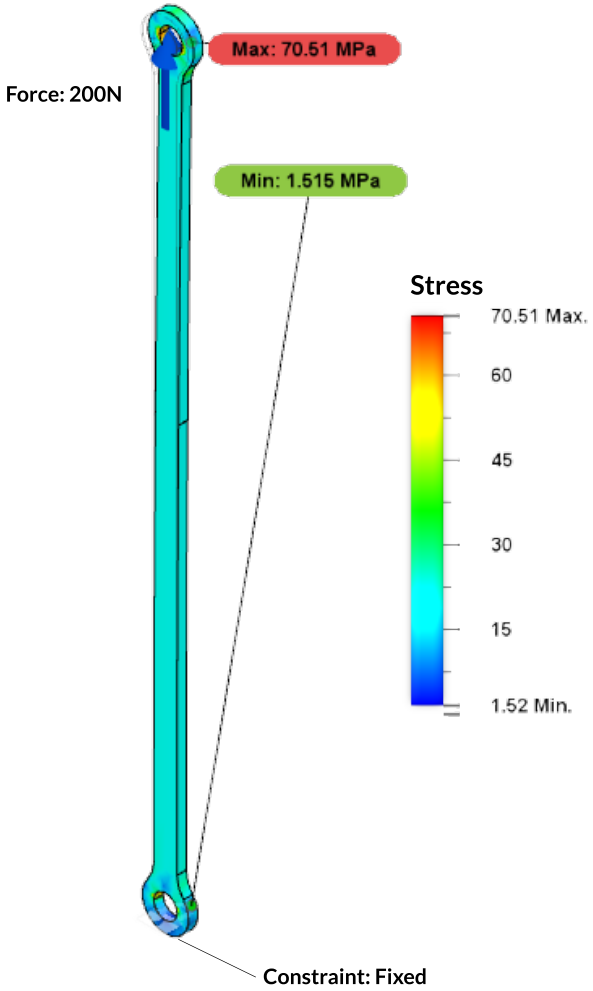
$\sigma_{max} = 20\ MPa$

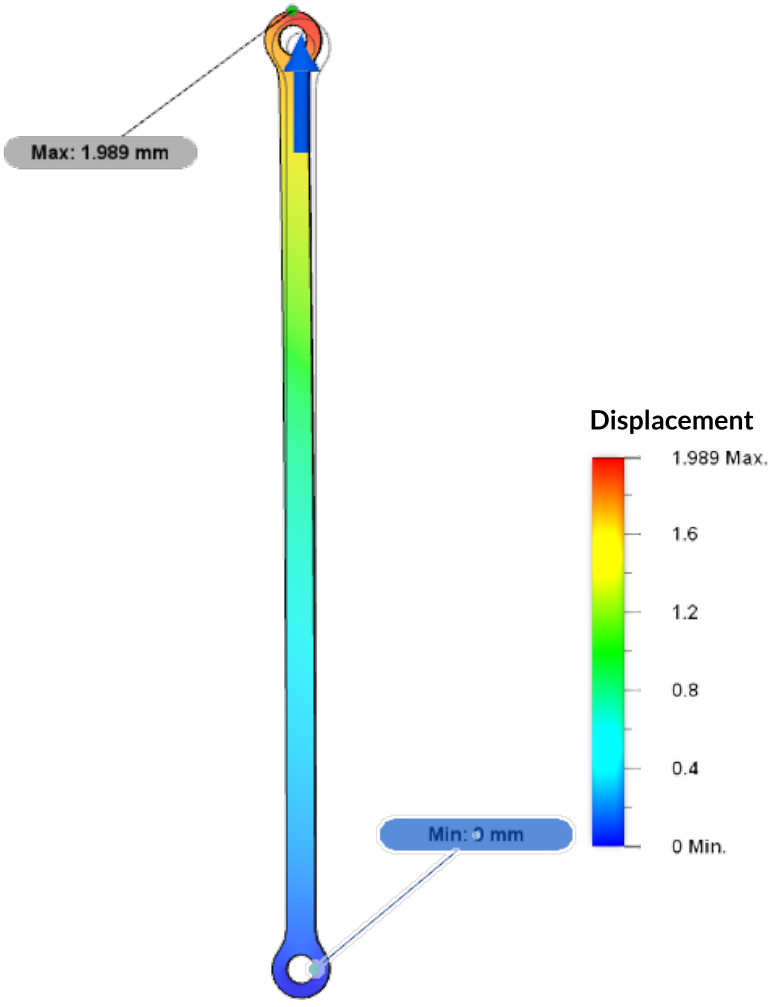
$FoS = \frac{60(\cancel{10^6})\,\frac{\cancel{N}}{\cancel{m^2}}\,(5)(2)(\cancel{10^{-3}})\,\cancel{m^2}}{200\,\cancel{N}}$

$= 3$ ✓


Max: 70.51 MPa
Min: 1.515 MPa

Stress


Force: 200N
Max: 70.51 MPa
Min: 1.515 MPa
Stress
70.51 Max.
60
45
30
15
1.52 Min.
Constraint: Fixed


Max: 1.989 mm
Displacement
1.989 Max.
1.6
1.2
0.8
0.4
0 Min.
Min: 0 mm