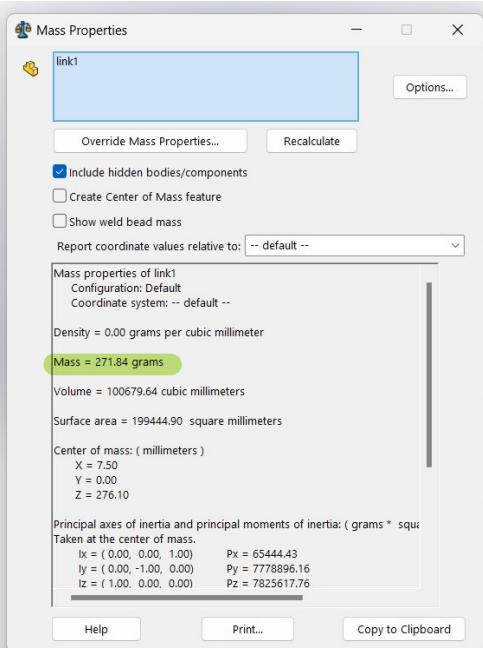
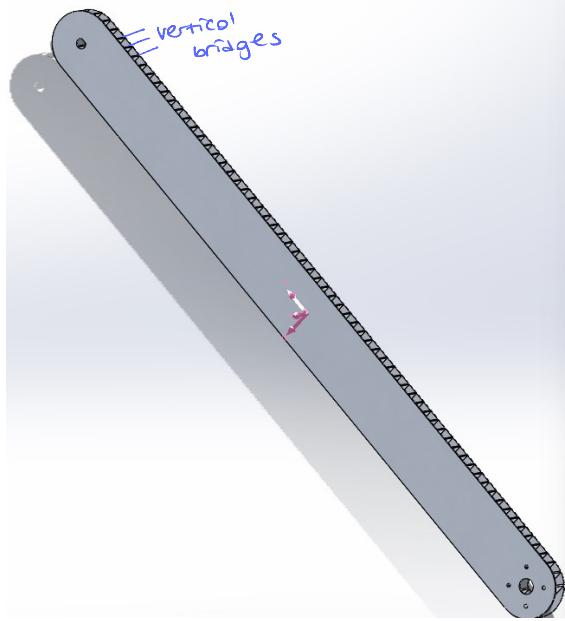


Project 1 - part 2:

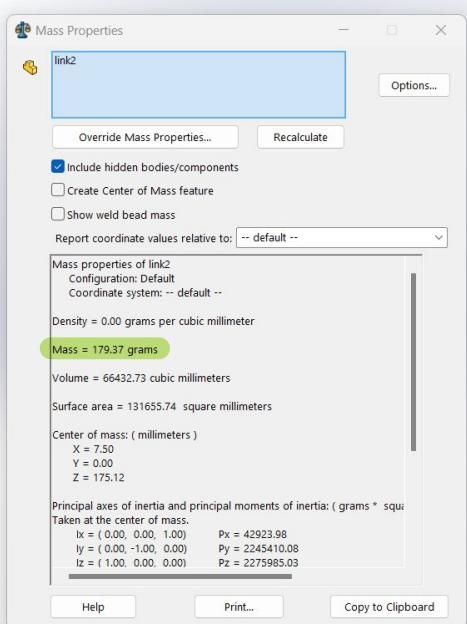
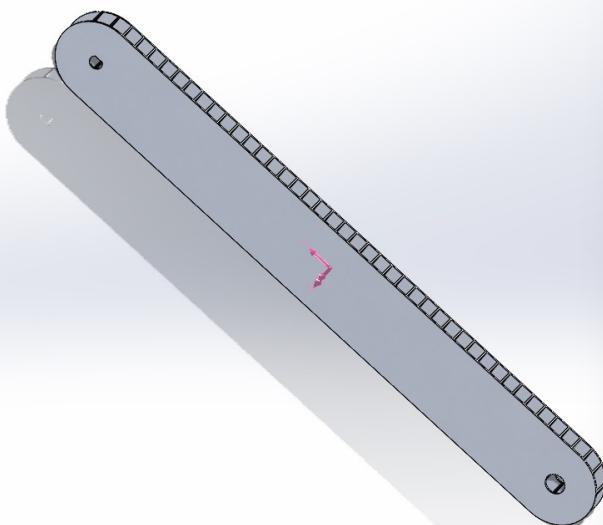
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Case 1: Vertical Bridges along the link

link1

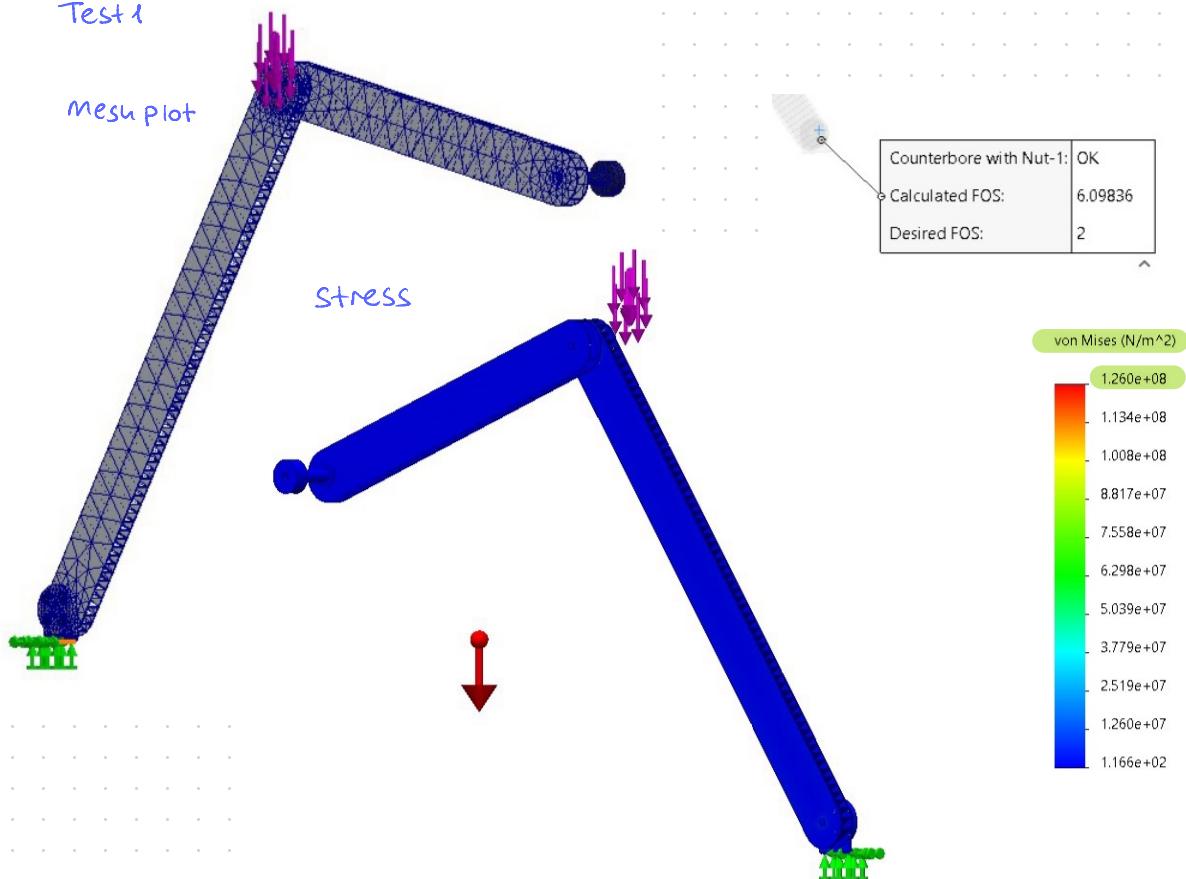


link2

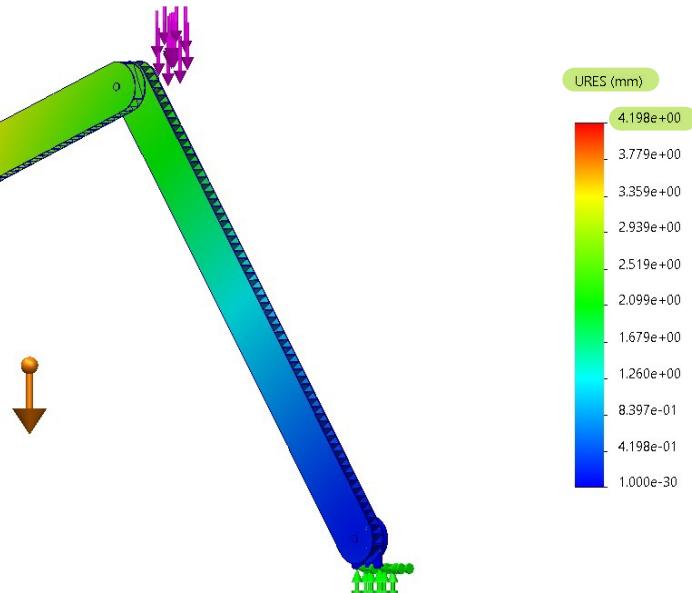


Test 1

Mesh plot



Displacement



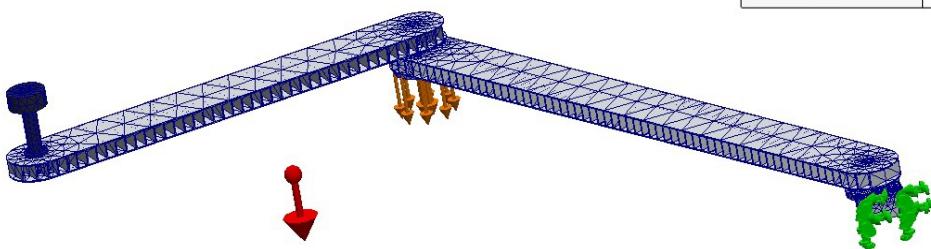
Counterbore with Nut-1:	OK
Calculated FOS:	6.09836
Desired FOS:	2

Test 2

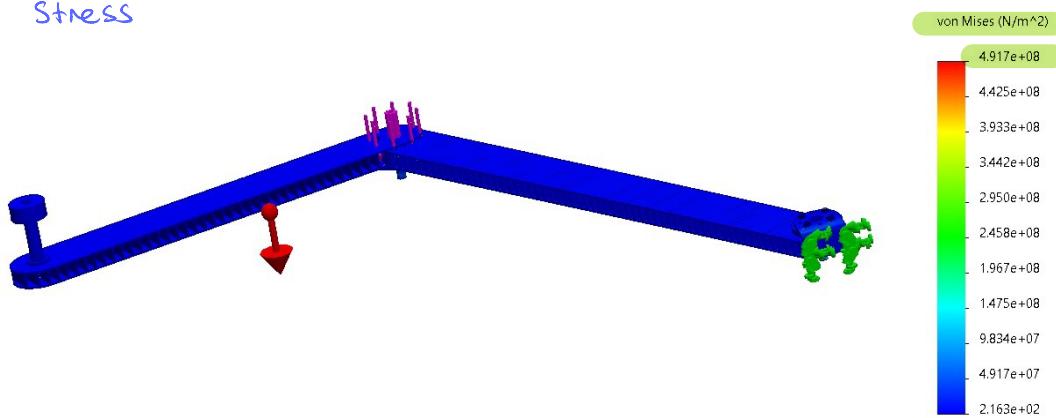
Pin-Bolt Check

Counterbore with Nut-1:	OK
Calculated FOS:	6.70166
Desired FOS:	2

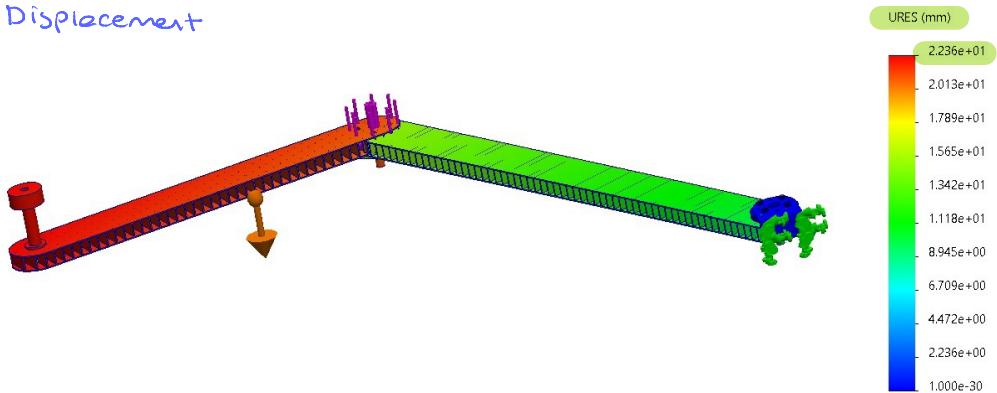
Mesh Plot



Stress

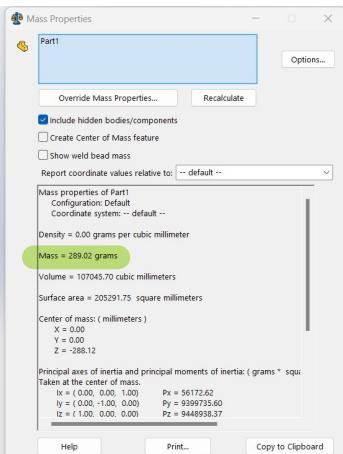
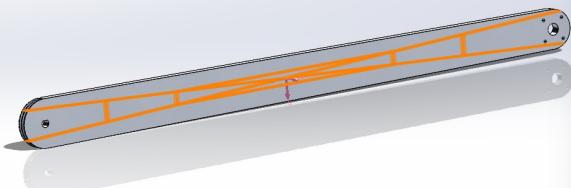


Displacement

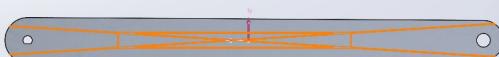


Case 2: 10mm wide shell (1mm) with cross slope bridges with vertical and horizontal bridges

link 1:



link2:

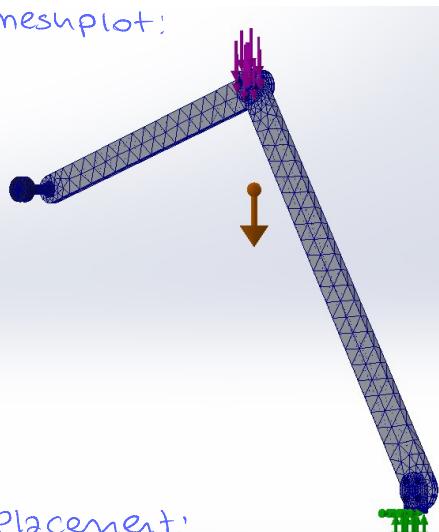


Assembly:

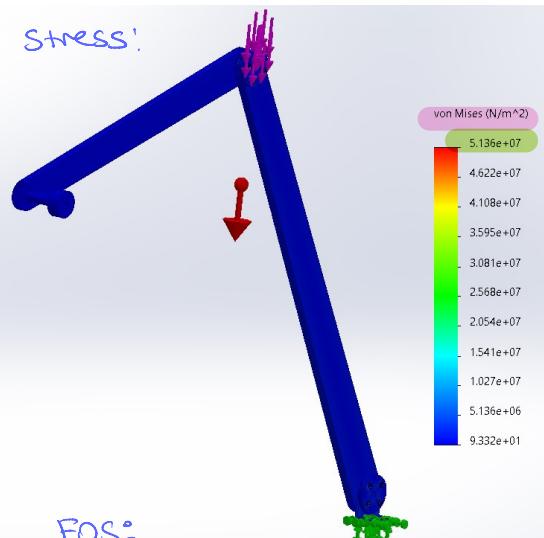


Test 1:

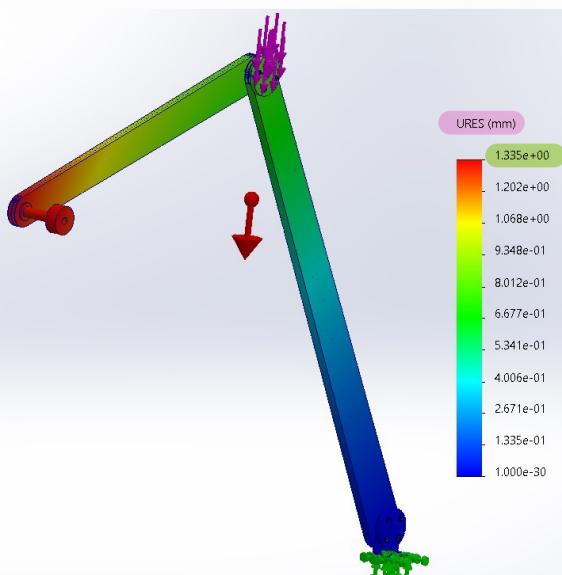
meshplot:



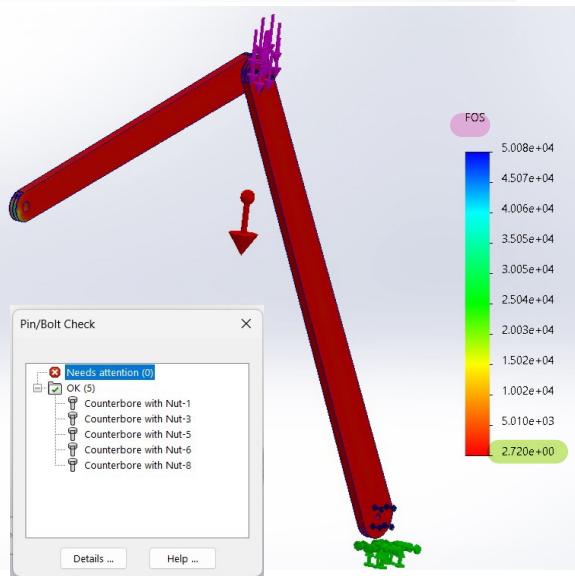
Stress:



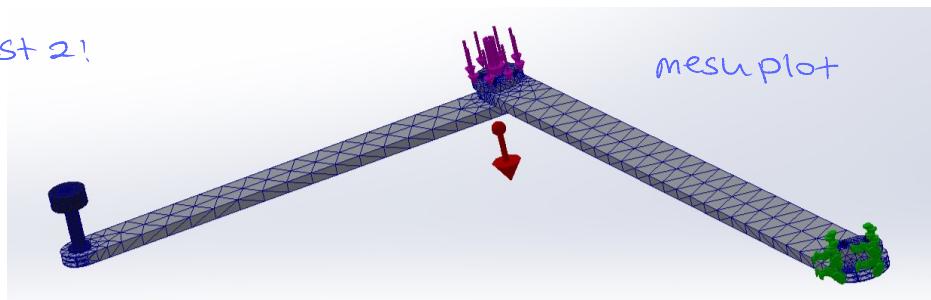
Displacement:



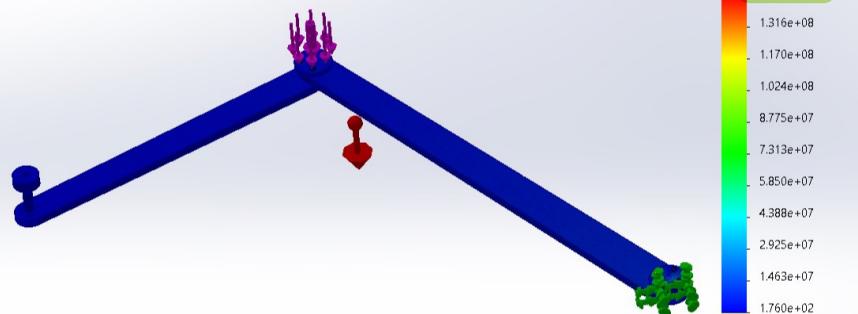
FOS:



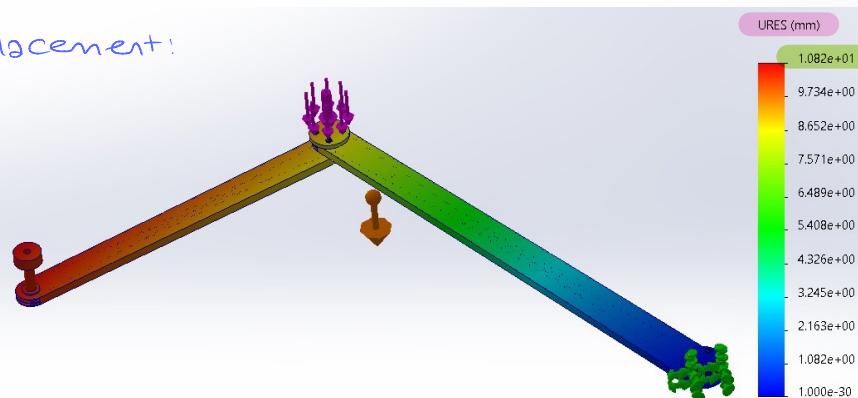
Test 2!



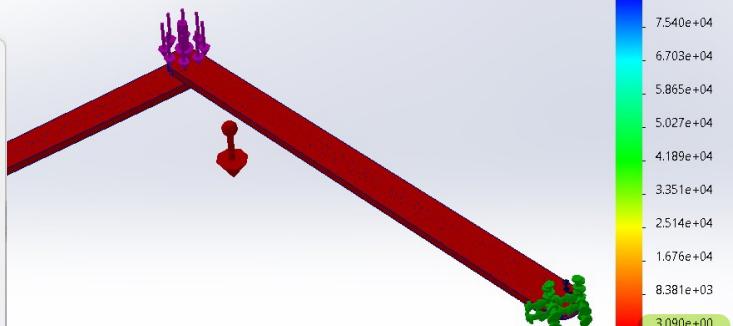
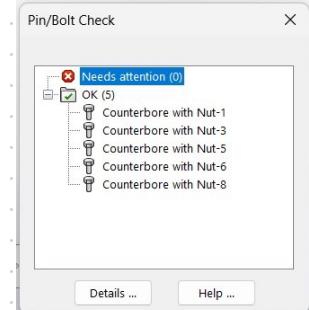
Stress:



Displacement:



FOS:

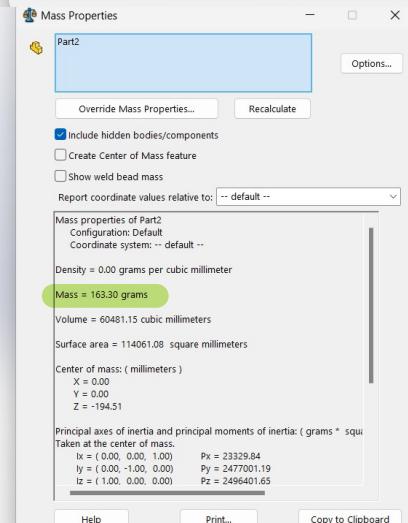
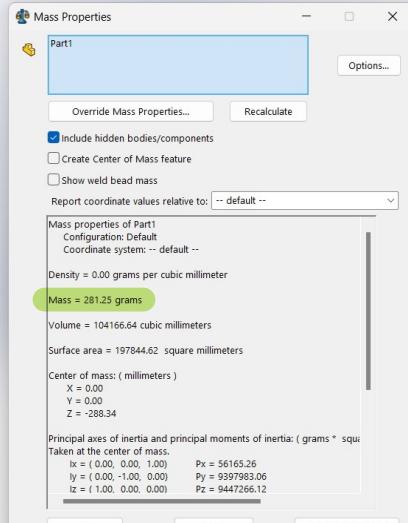
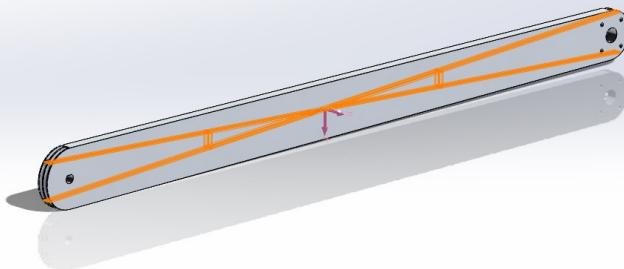


Case 3: no horizontal bridges between cross shape bridge but fillets added.

link1!

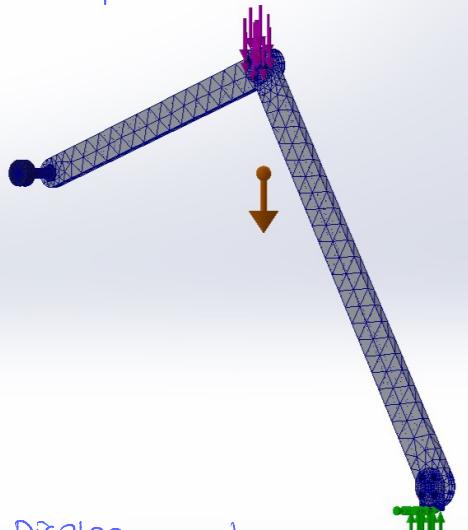
Boss-Extrude3

link2!

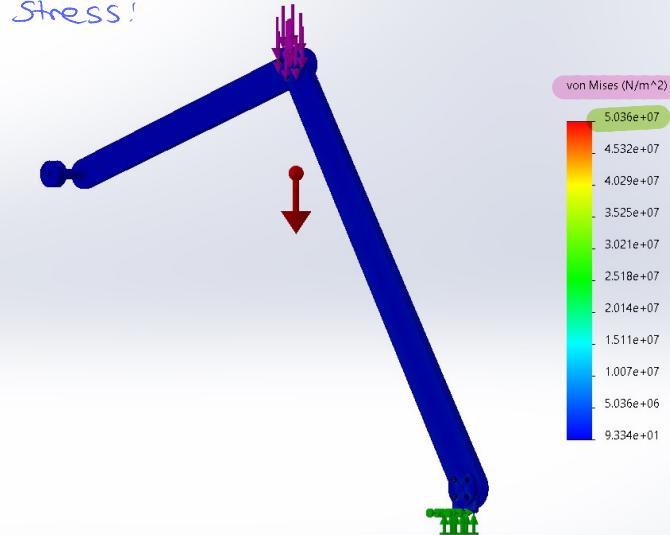


Test 1°

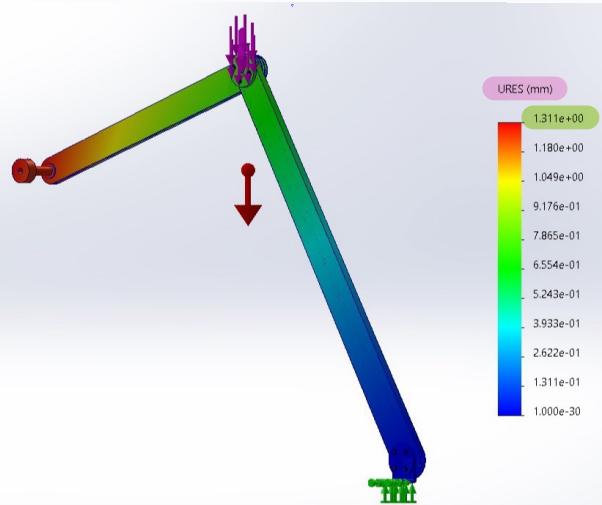
mesh plot



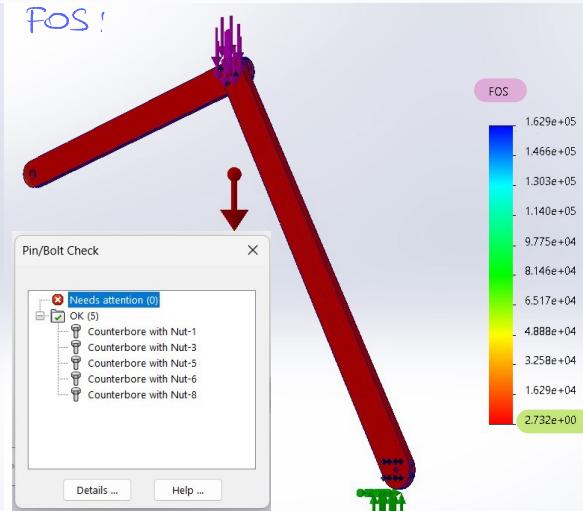
Stress!



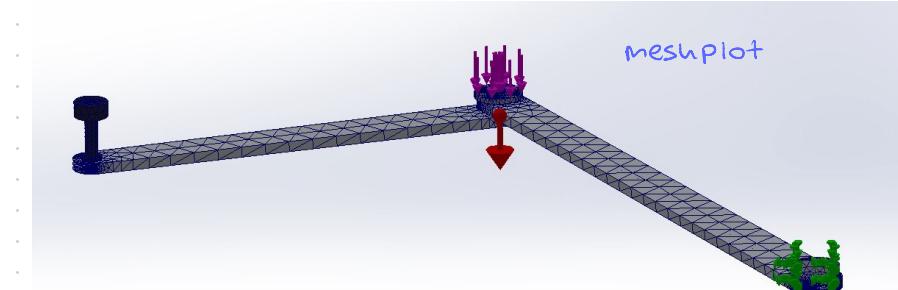
Displacement:



FOS:

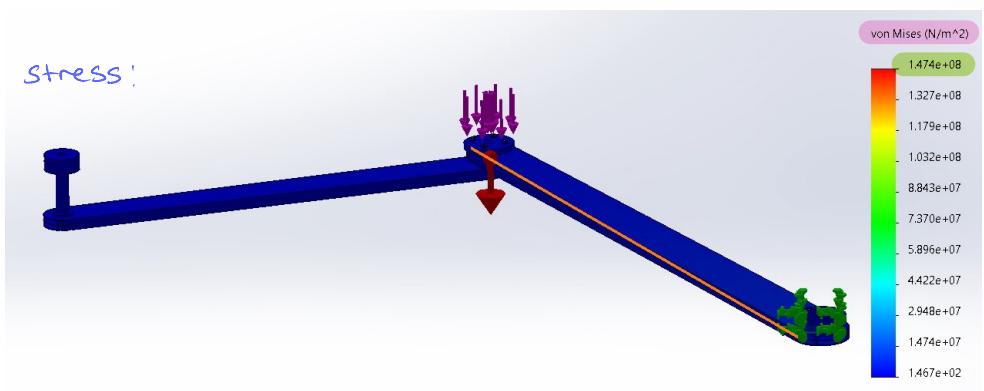


Test 2!

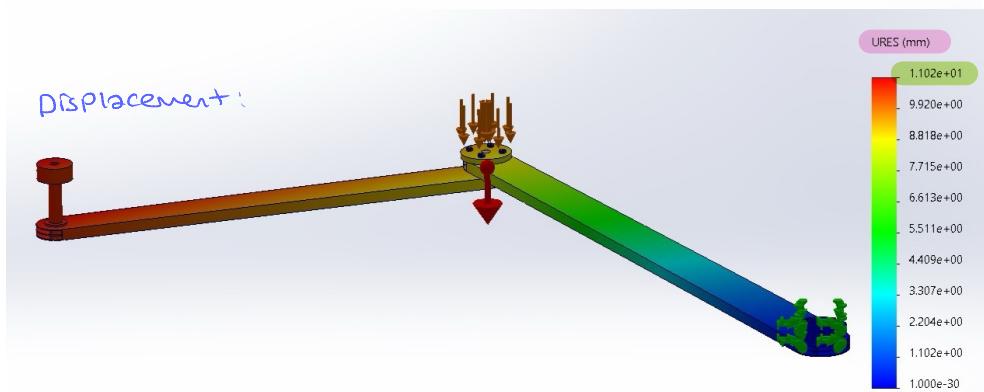


meshplot

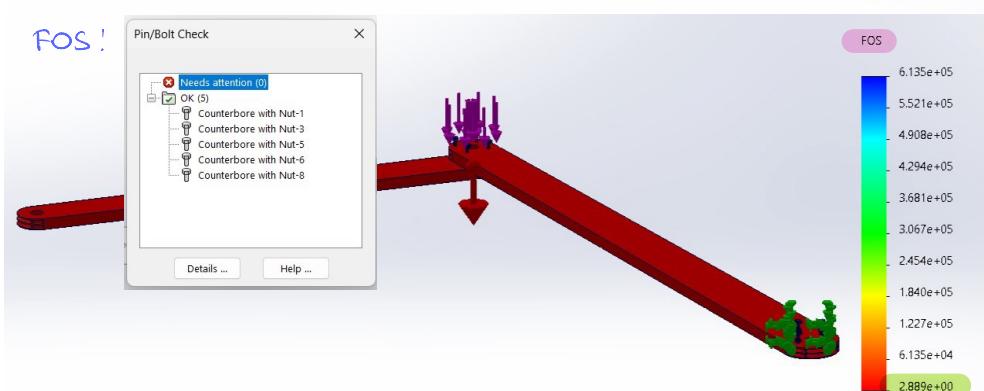
stress!



displacement!

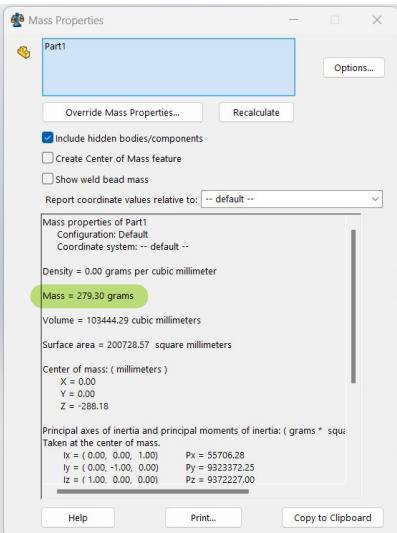
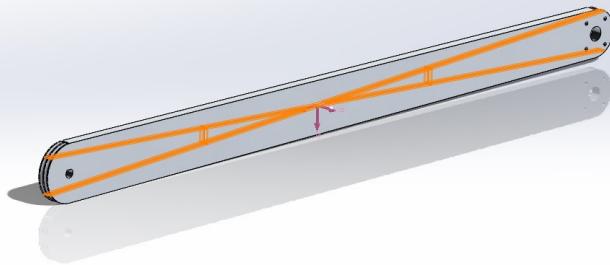


FOS!

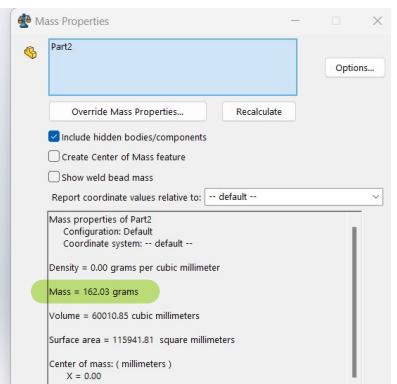
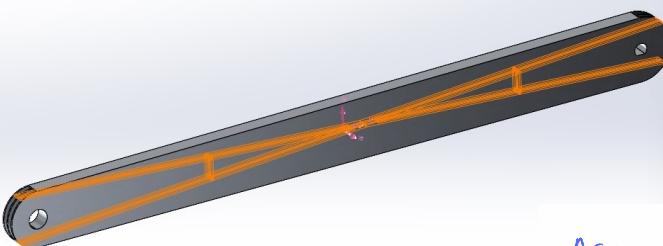


Case 4 : without fillets

link 1:



link 2:

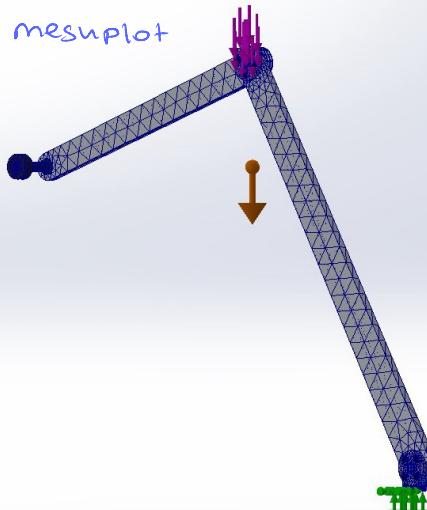


Assembly.



Test1:

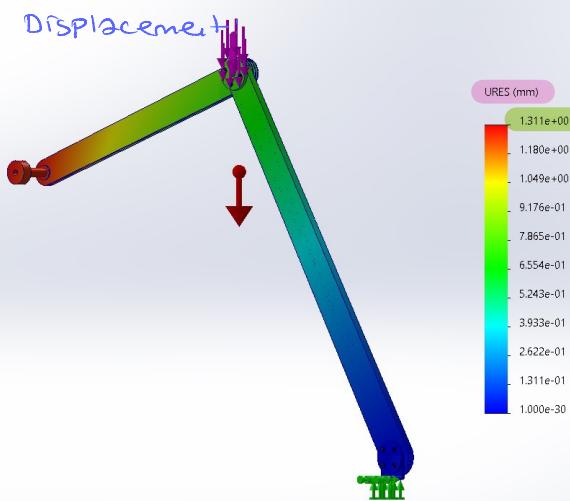
mesuplot



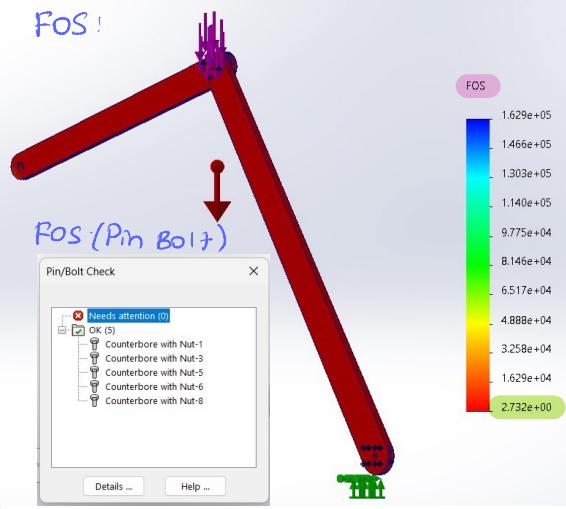
stress:



Displacement:

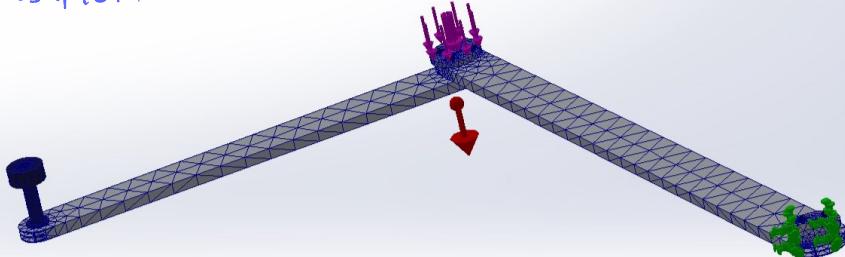


FOS:

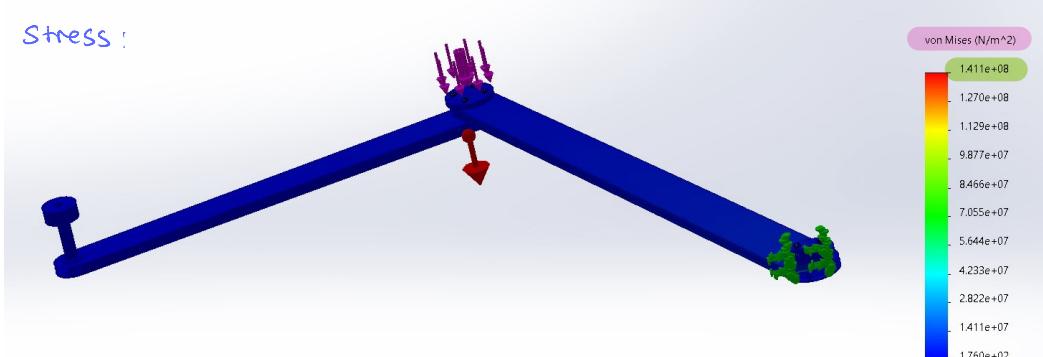


Test 2!

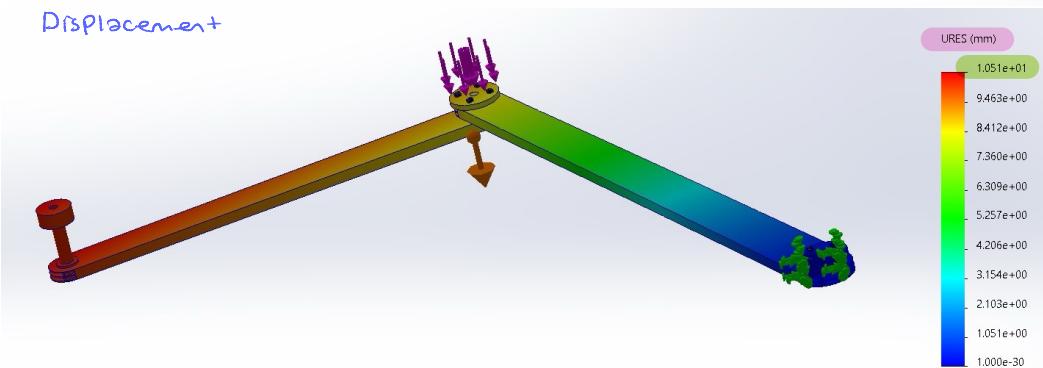
mesuplot!



Stress:

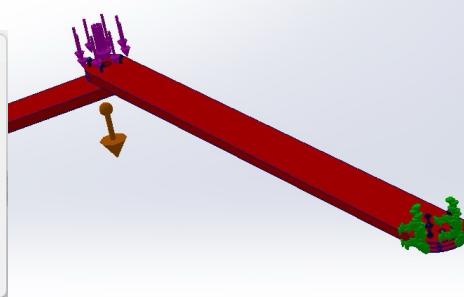


Displacement



Factor of safety distribution: Min FOS = 3.3

FOS!



Project Report on the Planar Elbow Manipulator

Introduction

This report details the design and simulation processes for the development of 2 DOF Planar Elbow Manipulator. The initial design specifications required the manipulator to maintain a total functional length of 1000mm and a total mass for both links below 500 grams. The objective was to design the manipulator's links in a way that they could withstand specified loads without exceeding the displacement limits set for two distinct test scenarios.

Initial Design and Simulation

The initial design, Case 1, involved constructing the manipulator's links from two 1mm sheets of aluminum, with vertical bridges added between the sheets to enhance structural integrity. The links were designed symmetrically with consistent cross-sections along their lengths. Despite these features, the initial simulation results were not within the acceptable range. Specifically, in Test 1, the displacement was measured at 4.1mm, and in Test 2, it escalated to 22mm, both exceeding the project's specifications.

Design Modifications and Refined Simulations

To address the excessive displacements, several modifications were made to the design. In Case 2, the cross-sections of the links were redesigned to be asymmetric, which involved:

- Adjusting the cross-section of link 1 to 50mm at the shaft center, tapering smoothly to 40mm at the motor connection over a length of 600mm.
- Designing link 2 with a starting cross-section of 40mm, reducing to 30mm over a length of 400mm.
- Implementing a shelling technique to the extruded boss of the cross-sectional area to a depth of 10mm, and removing rounded parts to reduce unnecessary mass.
- Adding a cross-shaped bridge and both vertical and horizontal bridges between cross-sections for increased stiffness.

These alterations led to significant improvements. In Test 1, the displacement was reduced to 1.335mm, and in Test 2, to 10.82mm.

Further Optimization

In an additional series of tests, various structural elements were adjusted to further optimize performance:

- Case 3: Removal of horizontal and vertical bridges and addition of fillets resulted in displacements of 1.311mm for Test 1 and 11.02mm for Test 2.
- Case 4: Subsequent removal of fillets decreased the Test 2 displacement slightly to 10.51mm, this may be due to the increase in mass caused by fillets.