AER1410 Project 1

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Q1 – Design of the Bracket

Siegmund's 88-Line Topology optimization code was utilized to reduce the computational time.

Parameters used :

1. Nelx = 150
2. Nely = 300
3. Volume Fraction = 0.133 (Calculations given below)
4. Penal =3 (default specified in class)
5. Rmin = 6 (explanation given below)

Volume Fraction Calculations

Volume Fraction for the T-Section was given to be 30%. Given, I am utilizing passive elements, the volume fraction given as input to the code is for the complete Design Domain of nelx*nely. Since our main concern is only the T-Section, we scale our volume fraction by the area of the T-Section in the Domain.

Volfrac = 0.3*(Area of T-Section)/(Area of Domain) = 0.1333

R-min

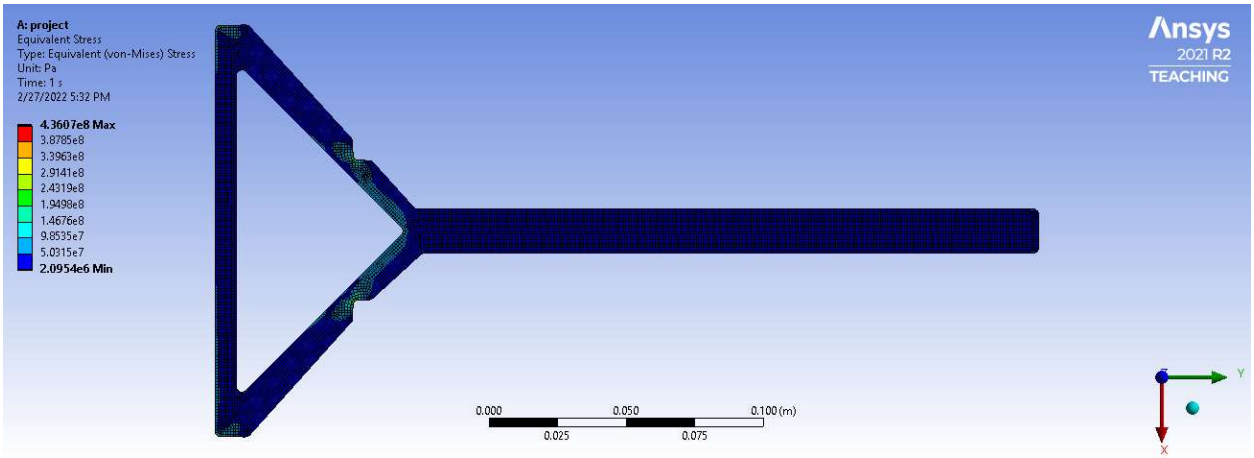
The topology optimization example shown in the class scaled according to the domain parameter. For the finer mesh grid with 600 elements, we used R-min of 12. Since my mesh grid has 300 elements in one direction, I chose the R-min value to be 6. I also tried with 4,5, and 7. The solutions for 4 and 5 had a small triangular hole in the center, which turned out to be an inefficient design as compared to the current Design, while the R-min value of 7 gave the same design as 6. Thus, I fixed the R-Min value of 6.

Q2 – Problematic Features in Optimized Design

The first problem we face as soon as we receive an output from the topology optimization code is the intermediate densities. The first step to producing the optimized design is to remove those intermediate densities, in my case, which is done using thresholding.

One key problematic feature seen in the Optimized Design is the abrupt cut occurring due to the domain constraint of the T-Section. As can be seen, this creates a sharp edge and can have adverse effect on the design strength.

Another major problem we can identify in the design is the stair steps in the final post-processed design. These steps make it a challenging task to manufacture the design. Replicating this design completely is simply not possible, both because of the manufacturing and the ability to accurately convert this design into CAD. Thus, further post-processing after this design is required to convert it into a manufacturable CAD design.

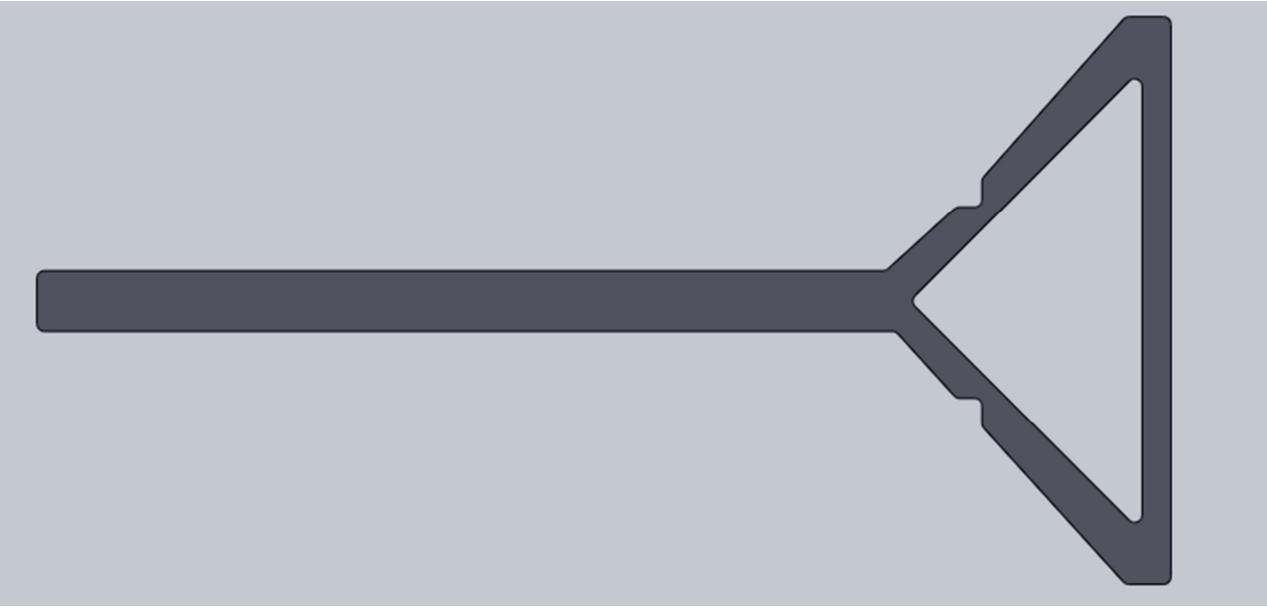


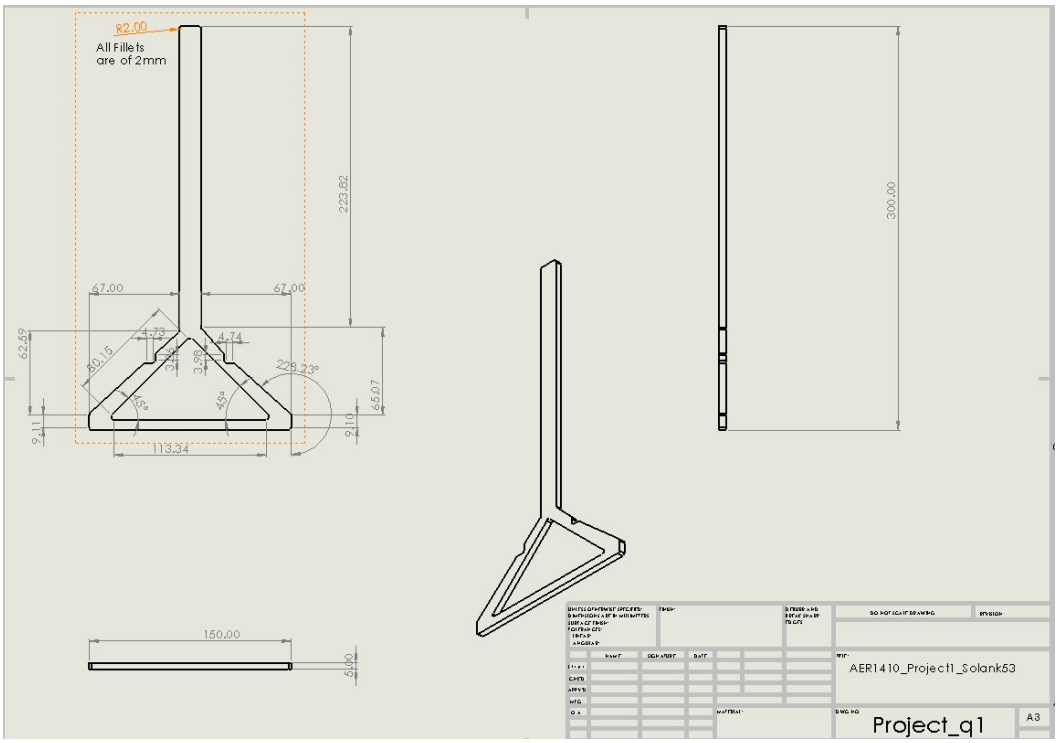
As can be seen in the result of the final simulation, even after adding fillets, the cut sections formed in the bars have a high stress concentration around them.

Q3 – Manufacturable Drawing

Below, I have provided the front-view of the CAD model generated after post-processing and removing the stair-steps received after thresholding.

I have also added the final drawing sheet here and added it in the submission zip file. The Manufacturing of the part is relatively simple, as they are straight 5mm thick bars, which can be welded together and cuts are made to remove the extra sections.





Q4 – Actual Bracket Results

[The Final code has been submitted with the settings of the actual bracket]

E = 69 GPa, nu = 0.3

Displacement according to the optimized design:

1. Y-Direction: - 3.5243mm (downwards displacement)
2. X- Direction: 0.3903mm (Right sided displacement)
3. Total Direction: 3.546mm

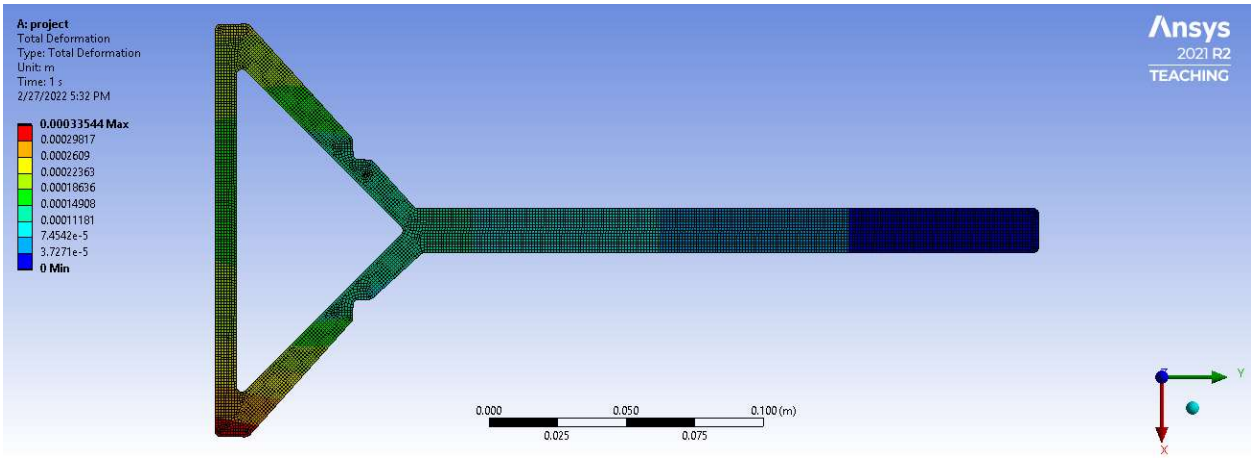
Displacement according to the post-processed (Thresholding) design:

1. Y-Direction: - 1.146mm (downwards displacement)
2. X-Direction: - 3.9574mm (left sided displacement)
3. Total Deformation: 4.1199mm

Displacement according to the Final result with smooth Edges(Computed using Ansys):

1. Y-Direction: -0.31mm (downwards displacement)
2. X-Direction: -0.09mm (left sided displacement)
3. Total Deformation: 0.39mm

The simulation result from Ansys



The huge difference after the post-processing and the final result is due to two main factors.

1. Smooth edges and small fillets added at the edges to make the design more robust and reduce stress concentration areas, which might lead to fatigue failures
2. Removal of the stair-steps which leads to increased stress and as a result more displacement.