ME396 LAB: ASSIGNMENT WEEK 2

Static Structural Cover

Abstract

A safety factor of 2.3736 was obtained by increasing the width of the back cover.

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I. Introduction

A cover under a load of 1.5 MPa load is retained by bolts. The goal of the simulation is to determine whether the cover will be capable of handling the 1.5 MPA pressure load that is applied at its back surface. The main objective is to obtain a safety factor between the range of 2 to 2.5 (inclusive).

II. Problem Statement

A control box cover is to be used in an external pressure application (1.5 MPa). The cover is made of aluminum alloy. The goal of the simulation is to verify the cover will function in its intended environment. Frictional supports are being used to model the constraints on the counter bores, bottom contact area, and inner sides. Translational displacement is allowed in all directions except into and out of the supported plane. The load consists of 1.5 MPa that is applied to the 17 exteriors of the cover. Measurement units for distance and pressure in the context of simulation and tabulation are expressed in millimeters (mm) and Megapascals (MPa), respectively. The width of the cover referenced in the preceding sections is measured from end to end in a side view section view.

III. Method

Original Design Simulation Results from in-lab:

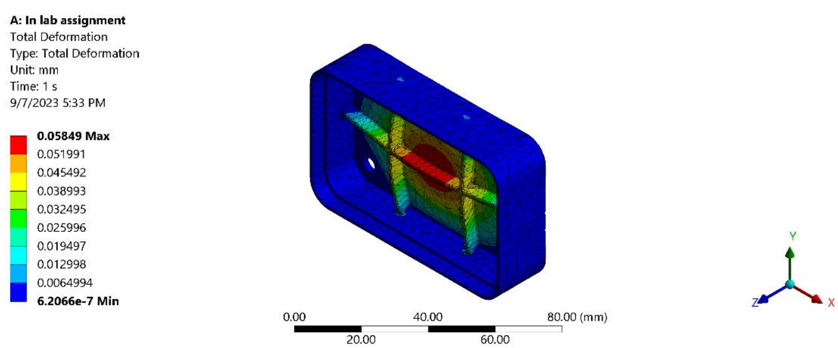

Figure 1: Total Deformation of original design (Aluminum alloy)

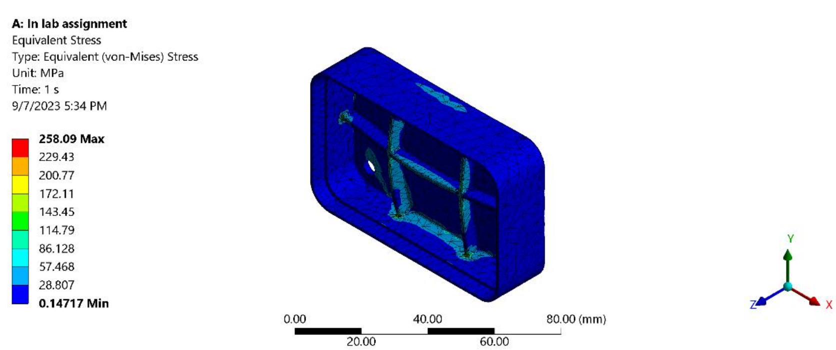

Figure 2: Equivalent Stress of original design (Aluminum alloy)

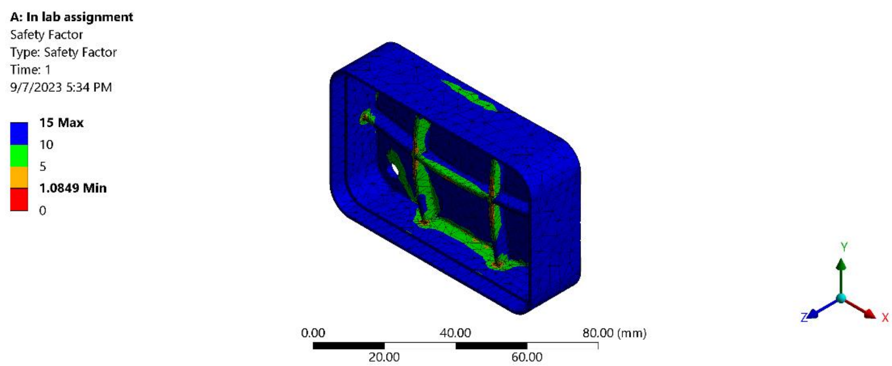

Figure 3: Safety Factor of original design (Aluminum alloy)

In the original design, a 1 MPa load was applied to the back surface of the cover. The solution of the simulation showed a resulting safety factor of 1.0849. This value is barely within the threshold of what is considered appropriate and safe. According to figure 1, most of the deformation occurred where the pressure load was applied and caused the back surface to move inwards. Therefore, my intuition told me to increase the thickness of the back surface such that the applied pressure can be distributed throughout the material to counteract the shortcomings of the in-class lab portion. By increasing delta X (width), the applied pressure would be more evenly distributed. This concept is borrowed from mechanics of materials. In my designs, I kept aluminum alloy as my material in all subsequent iterations.

Here are the first two iterations of my improvements. I noticed the safety factor went up to 4.2793 in fig. 4 the first time. This meant the thickness amount was far too much. Thus, I started decreasing the amount of thickness on the back surface of the cover. On my second iteration, I obtained a safety factor of 2.9704 as shown in fig. 1.

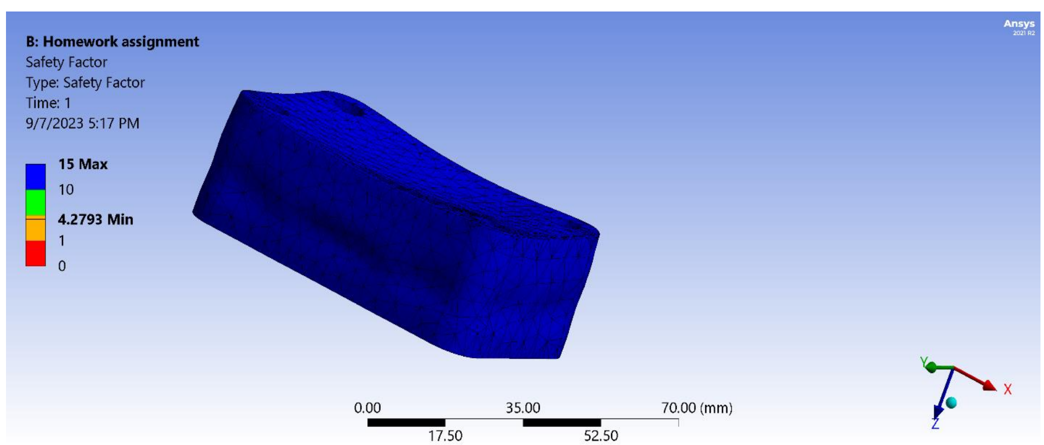

Figure 4 Safety Factor solution with a 28.6244 width.

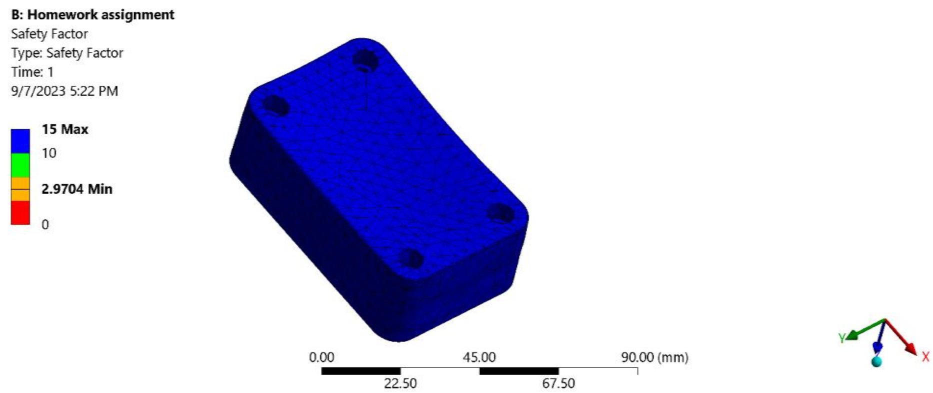

Figure 5: Safety Factor solution with a 25.6249 width.

IV. Results

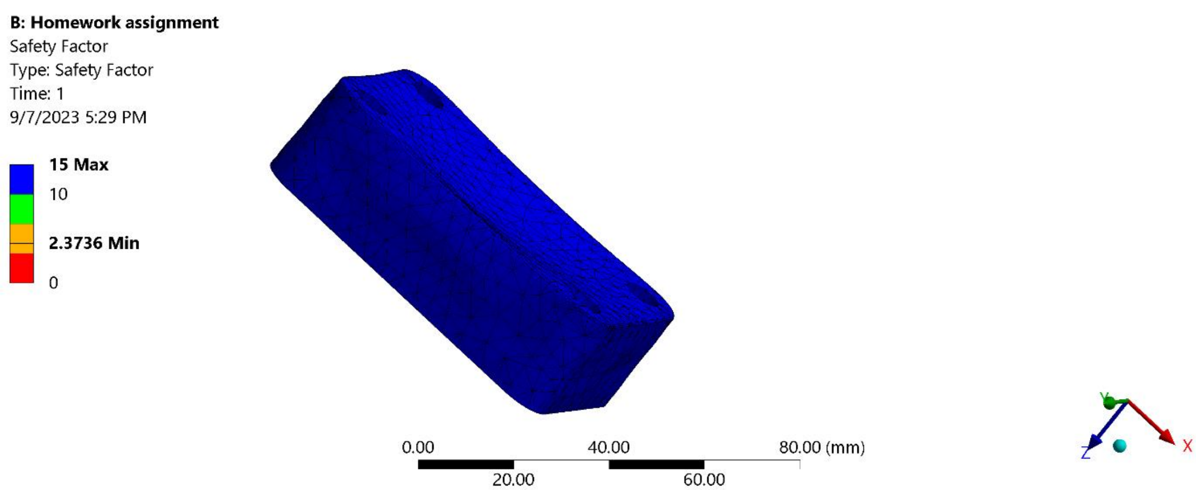

Figure 6: Safety Factor solution with a 24.1252 with.

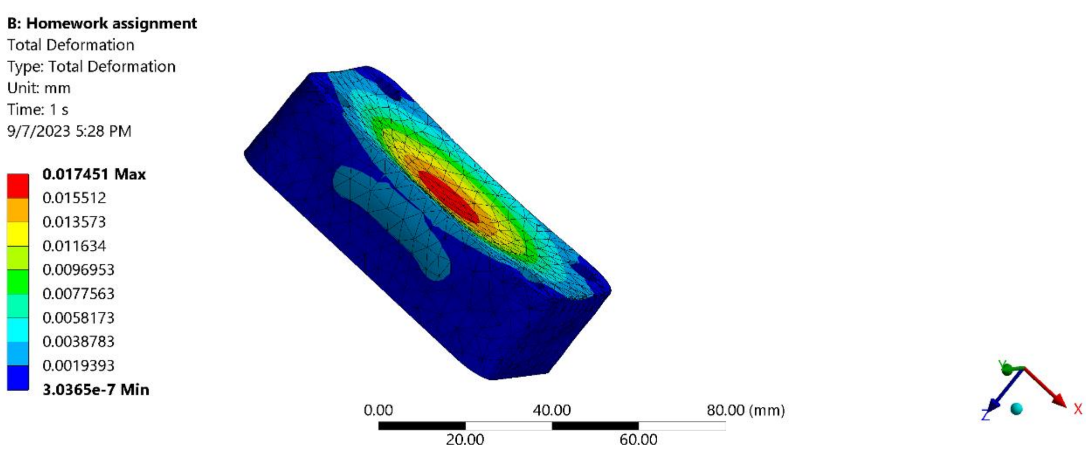

Figure 7: Total Deformation solution with a 24.1252 with.

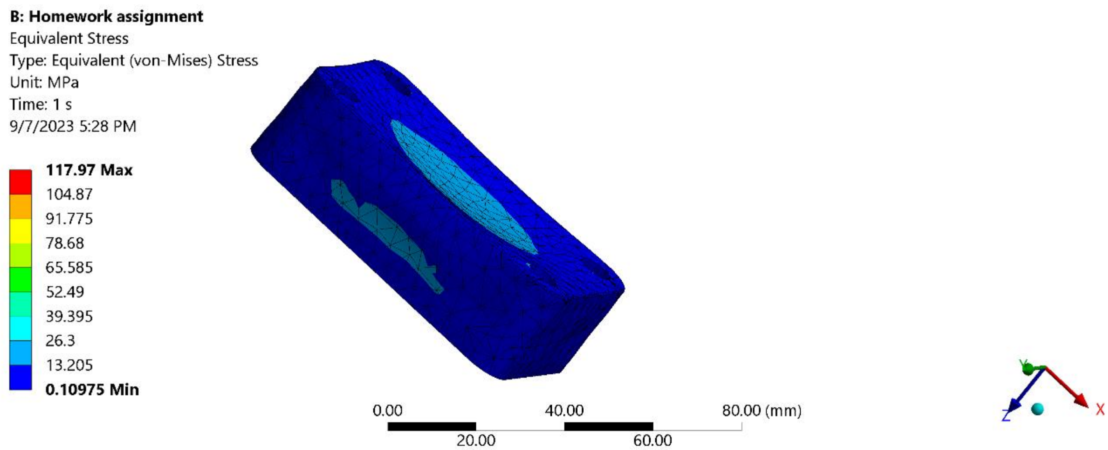

Figure 8: Equivalent Stress distribution with a 24.1252 width.

As seen by fig. 6, a safety factor of 2.3736 was achieved. This safety factor is within the range of 2 to 2.5. Additionally, fig. 7 shows a 0.017451 mm of total deformation. In the original lab assignment, the total deformation was 0.05849 mm with a 1.0 MPa applied pressure load. Even with a 1.5 MPa applied pressure, the total deformation was less compared to the original lab simulation. Overall, the integrity and strength of the cover increased as shown by the simulation results. The cover can now handle a 1.5 MPa pressure load appropriately with an adequate safety factor. All requirements have been met.

V. Conclusion

The results of the final simulation showed a safety factor of 2.3736, a total deformation of 0.017451 mm, and an equivalent stress of 117.97 MPa. The main objective of the safety factor to fall within the 2.0 and 2.5 (inclusive) range was successfully completed. In this lab, I learned how to perform a Static Structural (Mechanical) simulation. Additionally, I changed various properties within Spaceclaim, geometry, and the model part of the static structural simulation. I also learned how to apply boundary conditions including a total deformation, equivalent stress, and a safety factor as part of my solution. Finally, I learned how to successfully redesign the cover within Spaceclaim such that it met the criteria of a 2.0 to 2.5 safety factor.