Lab 3 – Riveted Joints

Section 5, Group 5
Ethan Pickard, Isaac Pollard, Joseph Spewock, Lucas Tavares
09/22/2023

Introduction

To gain a more concrete physical knowledge of the impact of stress applications on components, specifically riveted sections, we were tasked with analyzing a 2-2 rivet design and its joint efficiency to determine a possible alternative which would ideally provide overall better resistance to plastic deformation. With this preliminary info, we constructed a new rivet pattern and subjected it to a destructive evaluation. This gave us valuable insights on rivet quality and types of failure across riveted structures.

Methods and procedure

This lab relied heavily on the work that was required for the prelab. Every group member was supposed to come up with a new rivet design and calculate the joint efficiency for the four modes of failure along with the maximum loads that cause each type of failure. The new designs were than compared among the group and a 2-3-2 rivet pattern was chosen. The 2-3-2 design was chosen over a 3-2, 2-1-2, and 1-3-1 rivet pattern because of the maximum loads that each design could withstand.

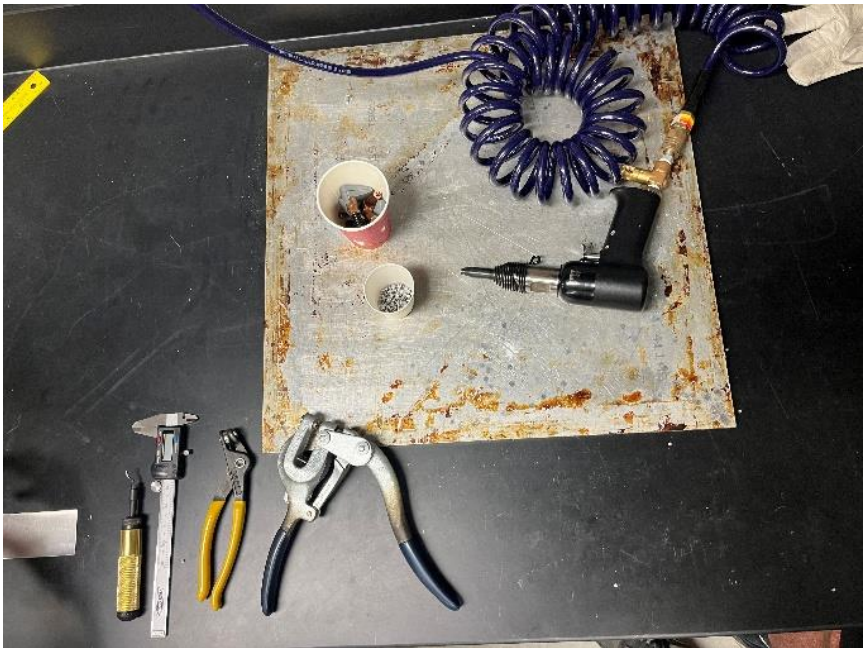

Figure 1. Riveting tools

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Once the rivet design was chosen by the group, a little bit of practice riveting needed to be done before the final product was made. To the right in Figure 1, you can see that the lab provided all the necessary equipment to make our rivets. Once everyone in the group got to practice some, the final design was ready to be made. The final design was applied to two 8" by 2" 2024-O Aluminum sheets overlapping by two inches, using 1/8"-diameter ¼" -length dome head, non-countersunk, rivets. The final product that was produced is shown in Figure 2, to the right.

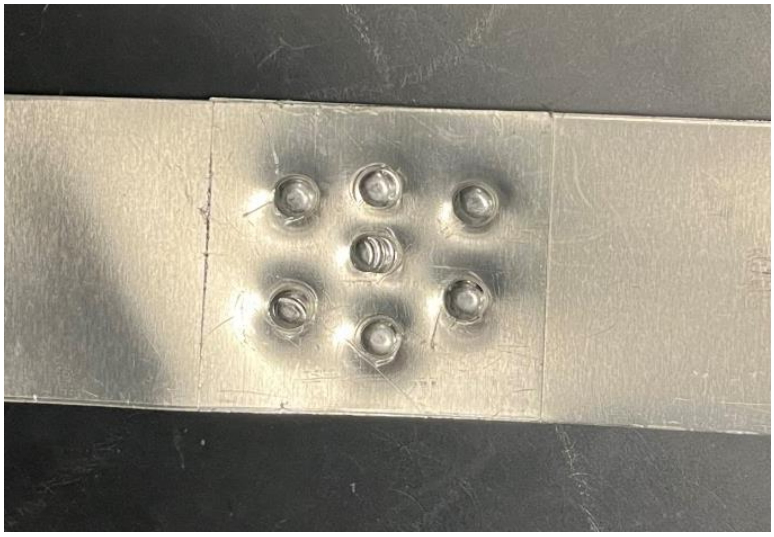

Figure 2. 2-3-2 rivet pattern

The two aluminum sheets riveted together were then tested to failure with a tensile test using the Instron dual-column materials test system (Figure 3). The test system was connected to a computer, which was used to collect data. Once the data was collected, the lab was finished.

Figure 3. Instron dual-column materials testing system

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Work Assignments

For the work that everyone in the group did, Isaac created the design that we used, which was a 2-3-2 rivet pattern. All four of us practiced the riveting and contributed to riveting our test panel. For the lab summary, Isaac wrote the introduction and conclusion. Ethan did the methods and procedure section of the lab summary. Joseph recreated the graph that was given in the tensile test in the lab. Then all four of us contributed to the analysis, but Lucas contributed to it the most out of everyone.

Data

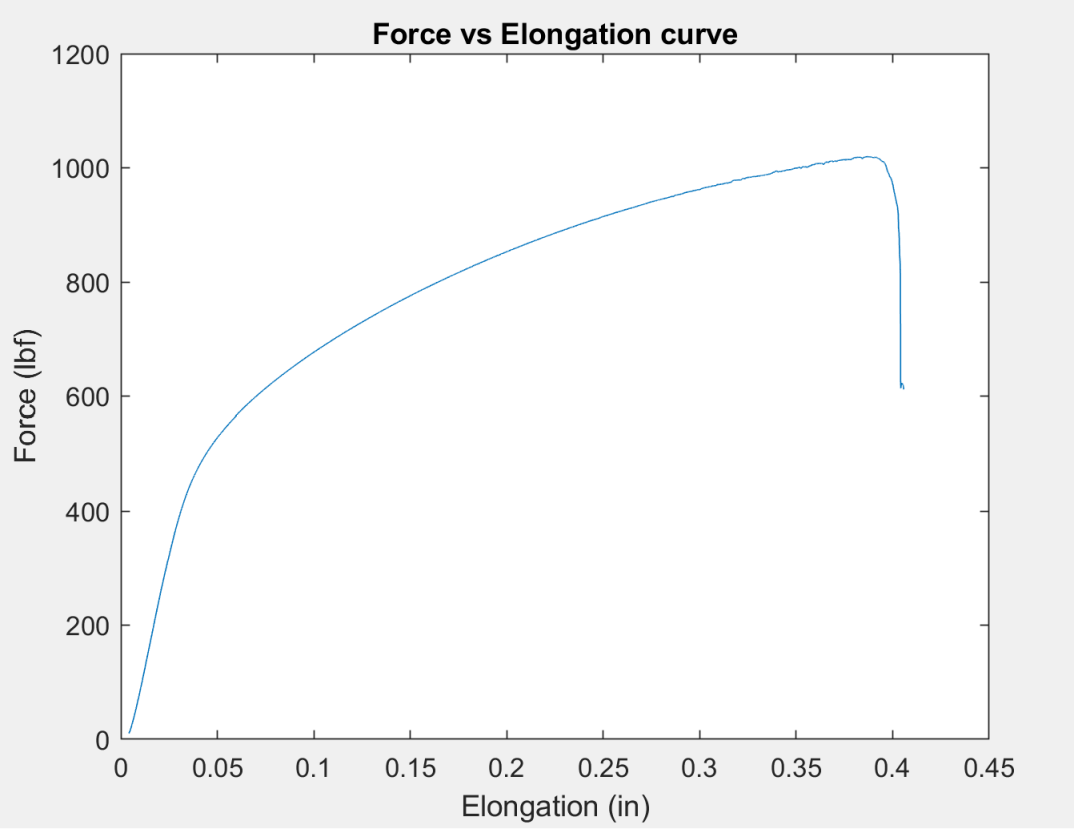

Figure 4. Force vs. elongation curve

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Analysis

We can observe on the Force vs Elongation graph the elastic and plastic deformations. The elastic deformation is represented by the linear section of the curve, on bottom left. The plastic deformation is represented by the curvilinear section of the curve. At around F = 1019lb and deformation = 0.39in, the rivet panel failed by tension in the first row, as observed in Fig. 5.

Figure 5. Rivet panel post failure

From pre-lab calculations, it was estimated that the 2-3-2 pattern would fail in tension at the first roll when it reached 1536 lb. It was also predicted that it would first fail in bearing when it reached 1094 lb.

Our manufacturing of the rivet panel was possibly the reason the experimental results were different from the values calculated during the pre-lab. It was everyone's first time riveting, so we already expected that our prototype would not be perfect. If you go back and analyze Fig. 2, it is clear the rivets aren't perfectly aligned. Additionally, we did not have enough time to measure our results and compare them to the MIL-R-47196A standard dimensions. We believe the dimensions weren't as precise as they should be. As our group only had a single attempt riveting the plates, we did not have the opportunity to settle and fix the design's problems.

Conclusions

After completing the testing and analyzing our findings, we determined that some small misalignment or scratching of the material was sufficient to cause early crack propagation leading to plastic deformation. Our 2-3-2 riveted joint ended up failing under a load of 1019 lb. The examination of the crack created along the bottom row of rivets proved insightful in determining the origins of the flaw. Our team had an equal hand in the installation of the rivets to allow each

member to achieve sufficient familiarity with the process of using the rivet gun. Our experience in the design and implementation of the joint, as well as the usage of the stress tester were uniquely valuable for solidifying our understanding of safe component design.