EGR 201L Lab Report 1

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EGR 201L

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2. Introduction & Objective(s)

This experiment attempts to measure the tensile strength of a metal subject of certain known parameters. It accomplishes this by recording the strain, force, and displacement of the specimen as a machine applies a force upon it. A sensor placed onto the specimen records the displacement of the specimen; these values are translated by software and are mathematically analyzed using MATLAB and relevant softwares.

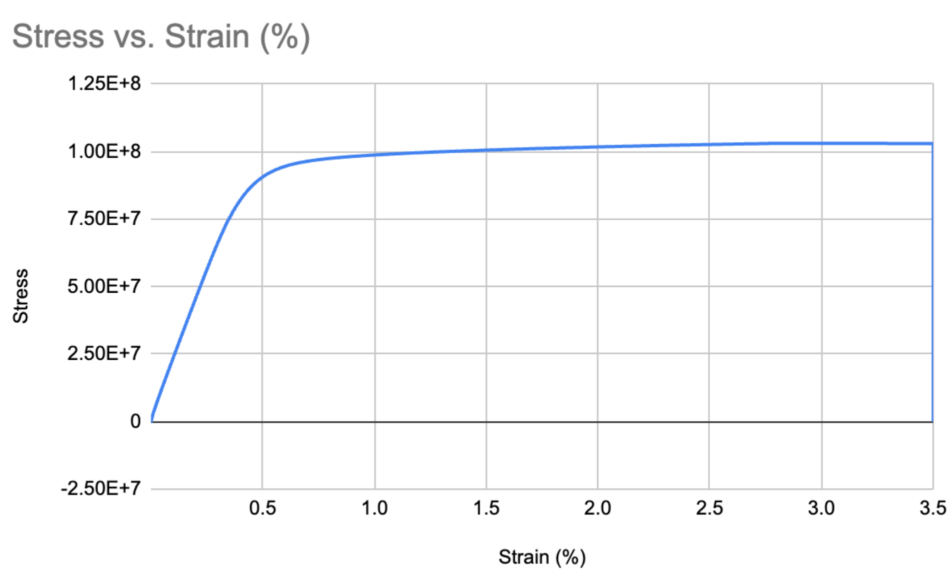
The objective of this experiment was to analyze the impact of tensile forces on certain specimens and understand how the results of our testing could be generalized to a larger sample of the tested metal. By testing a small subject, we are able to provide insights about the limits of such metal in larger applications in a much more pragmatic sense.

3. Methodology & Data:

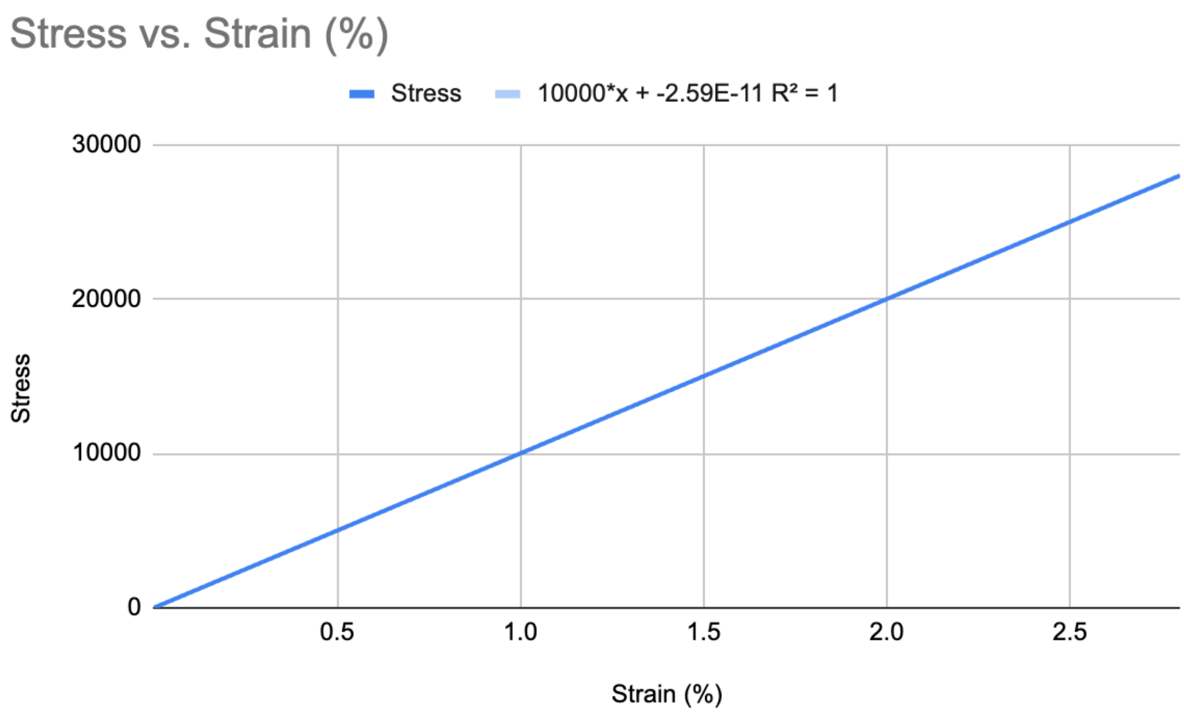
This experiment was interested in measuring three data variables during the application of force on the specimen, also noting a few details about the test specimen. In this particular experiment, a 6061-T6 Aluminum sample was used for testing. It had a hand-measured diameter of 9.3500 mm and a deforming length of 6.3600 mm. The gauge length of the extensometer was also noted at 50.7619 mm. While the force was being applied, the extensometer recorded the distance that the specimen had extended under force. The force and strain magnitudes were also recorded in real time. Refer to Appendix A for the plot of the individual and combined data.

4. Results:

At approximately 10307N, the specimen failed. Analysis of the data recorded in real time was used to generate a plot of the stress vs strain values of the specimen. We observed an elongation of about 5.6mm at the sensor's gage area. MATLAB and Microsoft Excel were both used to create the relevant graphs of the data, combined with known information about the specimen that was pre-recorded and noted in the data section above. Complications with MATLAB and newer Apple processors prompted the need to use excel as a supplement. A plot of the stress vs strain curve can be seen below to the right. Given stress = F / A, we calculate the cross sectional area as pi(6.35mm)^2 and calculate a stress value with respect to each recorded force applied in Newtons. The graph of this is shown below to the right.



The linear portion of the graph can be visualized alone. The following is apparent below:



Analysis of this data allowed for the calculation of the following variables:

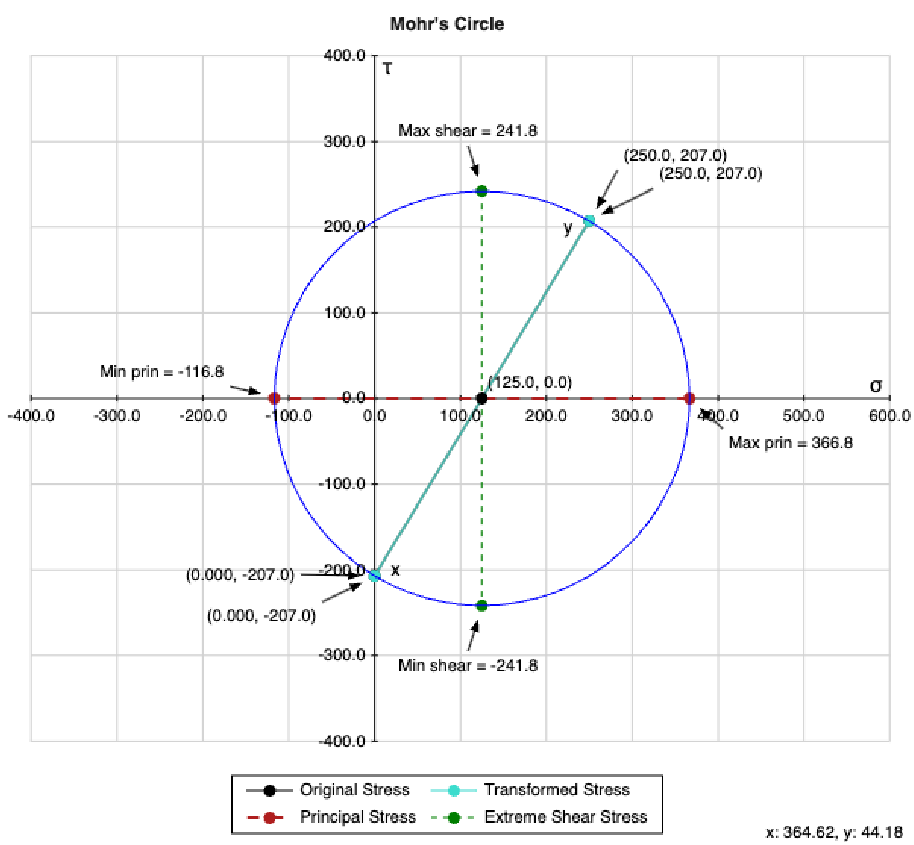
(a) Young's modulus, E, is equal to the slope of this linear graph, according to the lab manual. The slope, and E by extension, is 10000 ksi.

(b) yield stress, σy, which was derived using the parallel 0.2% adjustment, at approximately 101 MPa.

(c) ultimate stress, σu, was derived from observations about the maximum tensile stress applied prior to major ductility. This was estimated to be 106 MPa.

Comparing these values to results found in a materials guide (source 1), we observe that the E value for aluminum 6061 is understood to be 1000 ksi; this is exactly the same value we derived in our results. The results are otherwise inconsistent. The expected yield stress and ultimate stress should exceed 240 MPa, which is significantly more than what we had observed. Defective specimens, lack of repetitive testing, and measurement error could be possible explanations for this deviation.

With respect to constructing a Mohr's circle, we start by calculating the average normal stress and making this our center point and then inputting estimations of the shear stress of the subject using known information about the material. The result is the following Mohr's circle:



The image demonstrates a ductile fracture which appears consistent with the expectations of this particular test.

5. Discussion

A source described some of the properties of the specimen tested (with similar enough parameters such as diameter). Quoting from the source, "T6 temper 6061 has an ultimate tensile strength of at least 42,000 psi (290 MPa) and yield strength of at least 35,000 psi (241 MPa). In thicknesses of 0.250 inch (6.35 mm) or less, it has elongation of 8% or more; in thicker sections, it has elongation of 10%," (Source 1). We observed an elongation of approximately 5.6mm, which is 11.2% of the total gage length. This result seems consistent with the source's claims, however, the strength tensile and yield strength estimations seem to be much higher than our findings had indicated. Possible explanations for this include deformities or inconsistencies in the sample, improper measurements or translation of data, or perhaps error from the comparing source.

6. Feedback:

The process of configuring the specimen and getting to see how it will break under extreme pressure was fascinating to me and is what I enjoyed most about the lab. It was interesting to predict and see firsthand where the break point on the specimen would be and how long/what force was necessary to exceed its limits. I have little to no criticisms about this lab in particular; the instructions were easy to follow and went mostly without any issue. There were some minor deviances in the procedure based on the parameters of the specimen I tested (my specimen did not have a groove for the sensor to rest in), but this is a trivial issue. The lab manual was extremely specific and very intuitive, making this process seamless.

7. Conclusions:

We conducted a successful test of the stress and strain values leading to the failure of a specimen of interest. Comparison of the results of this experiment with others shows inconsistencies in the strength expectations of the material of interest, but similarities in the elongation of the specimen under pressure. This experiment may be improved by conducting a statistically significant number of trials of the same type of specimen to ensure experimental consistency and the reduction of outlier cases.

8. References:

(Source 1) *6061 aluminium alloy*. Ferguson Perforating. (n.d.). https://www.fergusonperf.com/the-perforating-process/material-information/specialized-aluminum/6061-aluminium-alloy/

The MathWorks Inc. (2022). MATLAB version: 9.13.0 (R2022b), Natick, Massachusetts: The MathWorks Inc. https://www.mathworks.com

Duke Engineering 201 Lab 1 Manual

Appendix A: Force, Displacement, and Strain Graphs: