1) a) The data taken from the given directory from my lab opened as an excel document, so I created a graph isolating those data and marked it on this .Word → .PDF

$\underline{x}$) $\sigma = E\varepsilon$, where E (Young's modulus) is the slope when σ-ε curve is linear (when material is elastic) $\begin{cases} E_{st} = 207\ GPa \\ E_{Al} = 70\ GPa \end{cases}$

✓

→ $\sigma = FA \rightarrow V = AL \Rightarrow A = \frac{V}{L} = \frac{V}{(L+\Delta L)}$

⚠ Area changes with time ⚠

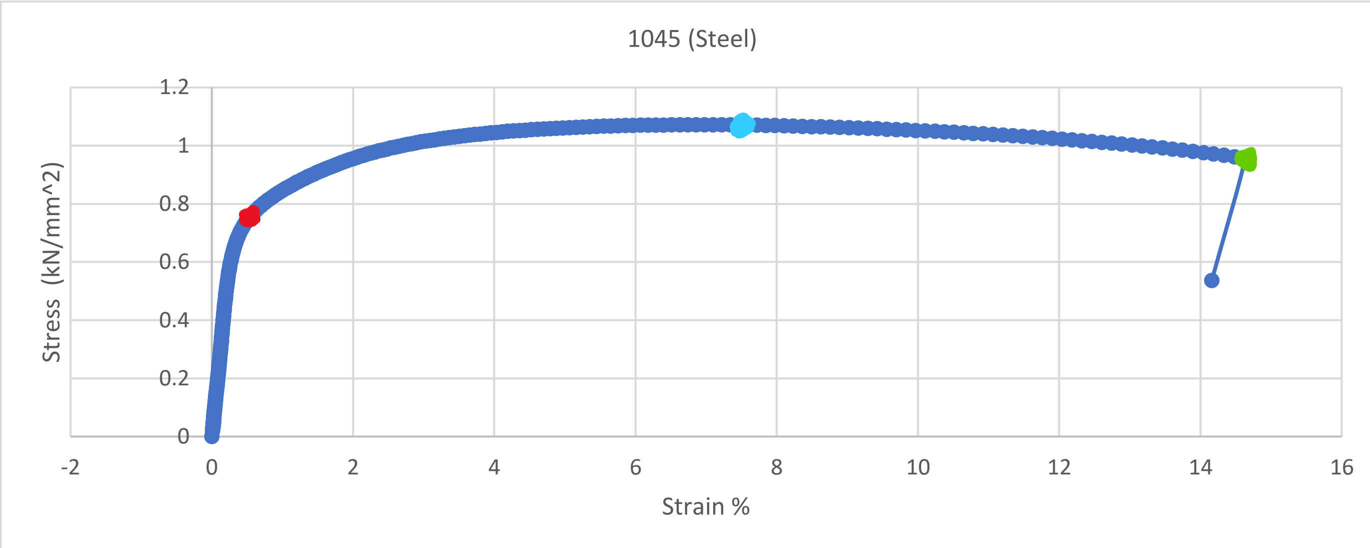
1045 (Steel) → $V = A_0 L_0 = 999.977\ mm^3$

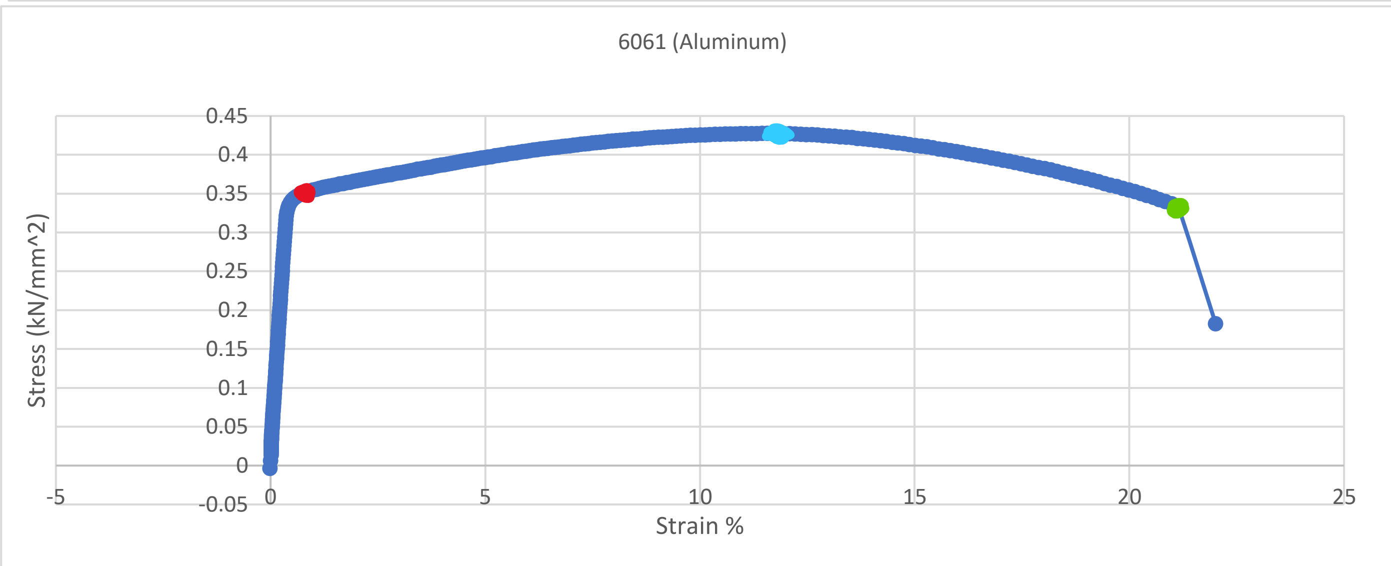
7075 (Aluminum) → $V = A_0 L_0 = 1019.649\ mm^3$

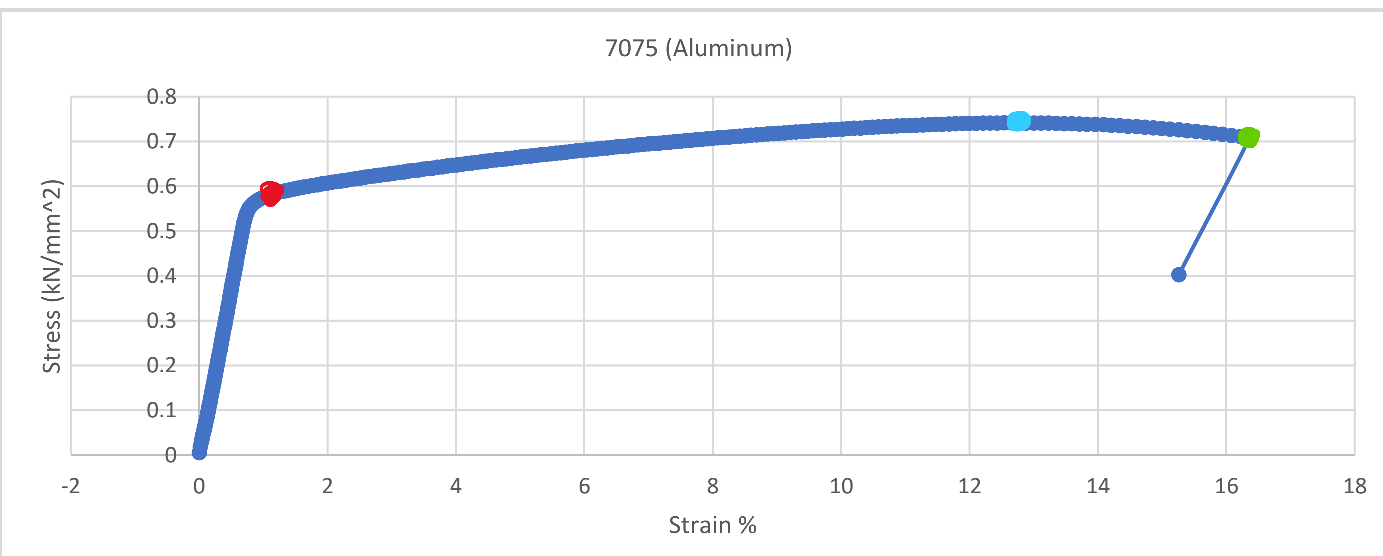
6061 (Aluminum) → $V = A_0 L_0 = 991.5204\ mm^3$

↓

b) • Yield Point • Point of onset necking • Failure Point







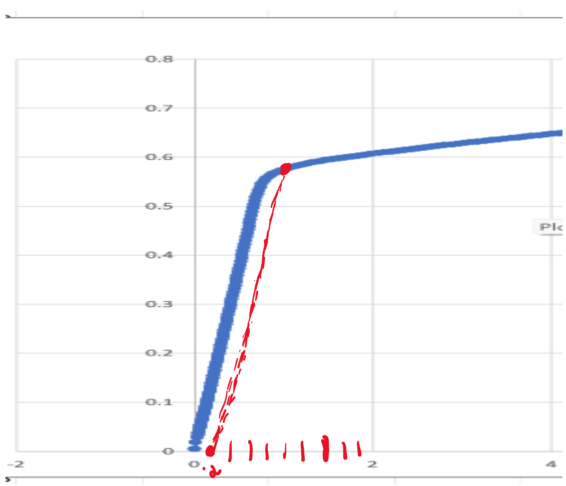
c) Proportional limit: upper bound of linear

1045 (Steel): $\varepsilon = .2973\%$, $\sigma = .6339\ KN/mm^2$

6061 (Aluminum): $\varepsilon = .4031\%$, $\sigma = .3314\ KN/mm^2$

7075 (Aluminum): $\varepsilon = .7375\%$, $\sigma = .5390\ KN/mm^2$

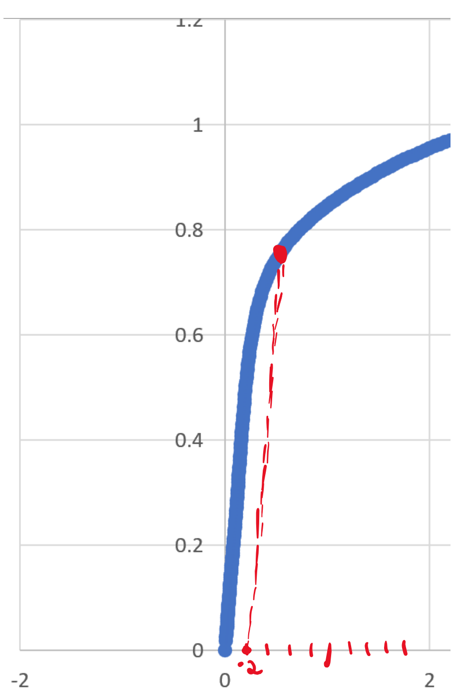
.2% Offset Stress:



7075 (Aluminum):

$\varepsilon = 1.273\%$

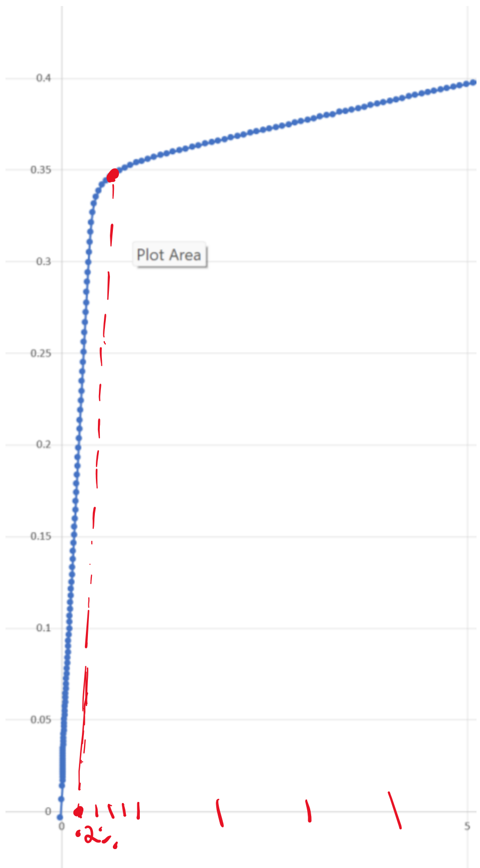
$\sigma = .58744\ KN/mm^2$



1045 (Steel):

$\varepsilon = .5395\%$

$\sigma = .7560\ KN/mm^2$



6061 (Aluminum):

$\varepsilon = .6578\%$

$\sigma = .34614 \ kN/mm^2$

Ultimate Tensile Strength:

7075 (Aluminum):

$\sigma = .7410 \ kN/mm^2$

$\varepsilon = 12.48\%$

6061 (Aluminum):

$\sigma = .42773 \ kN/mm^2$

$\varepsilon = 11.57\%$

1045 (Steel):

$\sigma = 1.0719 \ kN/mm^2$

$\varepsilon = 6.46\%$

Failure Strain: $\varepsilon = 16.36\%$, $\varepsilon = 14.63\%$, $\varepsilon = 21.14\%$

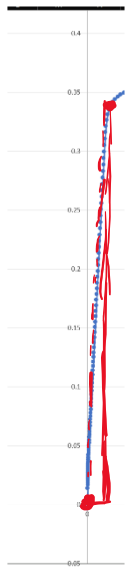
d) using curves, E (Young's modulus) is slope of linear portion

→ Starting from 0,0 $E = \frac{\sigma}{\varepsilon}$ $(\varepsilon,\sigma) = P$ (Proportional limit)

7075 (Aluminum)

$E = 73.085$

6061 (Aluminum)



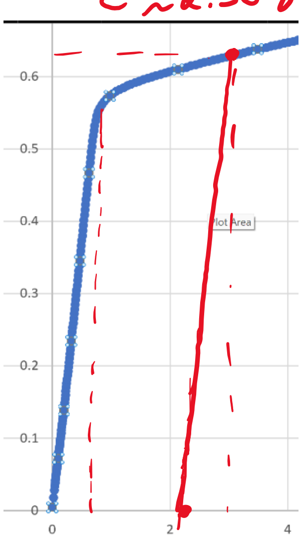
$E = 82.213$

1045 (steel)

$E = 213.22$

e) 7075 (Al.)

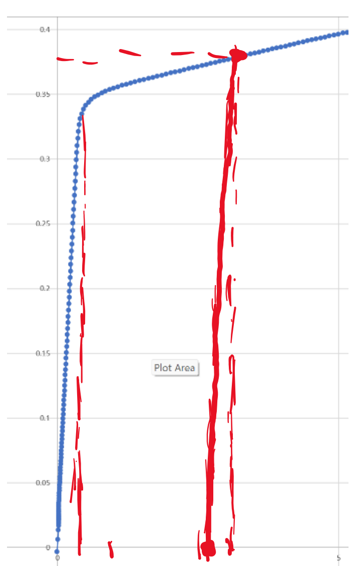
$\varepsilon \approx 2.358\%$



$\sigma = .628766$ kN/mm²

6061 (Al.)

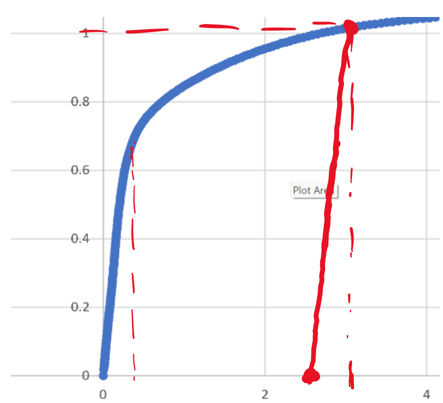
$\varepsilon \approx 2.645\%$



$\sigma = .37712$ kN/mm²

1045 (st.)

$\varepsilon \approx 2.532\%$



$\sigma = 1.0153$ kN/mm²

f) both Aluminum 7075 and 6061 had relatively equivalent necking strain ($\varepsilon \approx .12$ in), but 7075 was able to withstand $\sigma = .7410$ kN/mm^2 at necking, but 6061 only $\sigma = .42773$ kN/mm^2. However, 7075 failed faster after necking. This means although 7075 can withstand higher force, 6061 can hold with a similarly overloaded stress for longer. Young's modulus is larger for 6061 meaning it is a bit stiffer.

2)

Advantages of Using Epoxy/Carbon Fiber Composite (Boeing 787 Dreamliner)

The drastic amount of stress Epoxy/Carbon Fiber can withstand showing minimal strain can be found by looking at the Tensile Strength of the Composite and knowing that the Ultimate Tensile Strengths of both Aluminum alloys (<1MPa) and Cold Rolled Steel (~1MPa) are drastically smaller than the 876-1034 MPa range given. The directional tensile strengths also vary little, which is a good attribute to have in systems that involve pressure (differentiated forces). Furthermore, the elasticity modulus range of 67.9-71 Gpa is larger than those of Aluminum alloys by a factor of 10. This means the Epoxy/Carbon Fiber Composite is significantly more resistant to deformation within the larger elastic range. Similar to the Tensile Strength, the elasticity modulus varies little with the direction of tension.

According to Adam Quilter in “Composites in Aerospace Applications” for *Airframe Technology*, Composites in Aerospace application are extraordinarily useful “because of their exceptional strength- and stiffness-to-density ratios and superior physical properties” (pp.1). The density and extreme light weight alone are idealized for aircraft because drag and force necessary for lift increases largely with mass, which must be large for human application. That being said, the strength, previously compared with Aluminum alloys and Cold Rolled Steel, is remarkable, meaning the amount of material needed is less than it would be with less strength. A third advantage to having Carbon Fiber Composite in Aerospace applications is their resistance to temperature: the Tensile Strength and Tensile Modulus ranges change by less than 4% across a 76 degree Celsius range. The coldest temperature an airplane fuselage or wing would operate in is -54C (Div. Eng., et al) while the inside of planes are 23-25C (Drescher). The Epoxy/Carbon Fiber Composite is extremely strong, dense, and temperature resistant.

References

Division on Engineering and Physical Sciences; National Materials Advisory Board. (1999, January 1). *Accelerated aging of materials and structures: The effects of long-term elevated-temperature exposure*. The Effects of Long-Term Elevated-Temperature Exposure |The National Academies Press. Retrieved October 17, 2022, from https://nap.nationalacademies.org/catalog/9251/accelerated-aging-of-materials-and-structures-the-effects-of-long

Drescher, C. (2017, August 10). *The real reason it's always so cold on airplanes*. Condé Nast Traveler. Retrieved October 17, 2022, from https://www.cntraveler.com/story/the-real-reason-its-always-so-cold-on-airplanes

Quilter, A. (n.d.). *Composites in aerospace applications | aviation pros*. Retrieved October 18, 2022, from https://www.aviationpros.com/engines-components/aircraft-airframe-accessories/article/10386441/composites-in-aerospace-applications