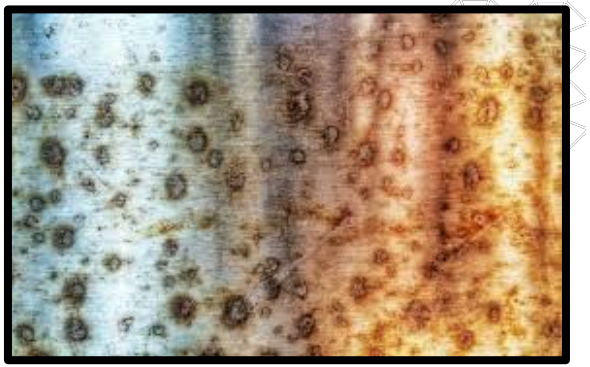
Custom Lab - Group 21
Investigating Aluminum Beam Degradation Due to Surface Oxidation

Phuoc Nguyen Andy Ho Jared Sitton Eric Bermudez Peter Bhatta

- Objective:
  - Determine the impact corrosion on the flexural rigidity(EI) and bulk modulus(K) of aluminum-6061-T4.
- Purpose:
  - Develop more robust designs that consider the reduction in strength due to corrosion.
  - Find levels of corrosion in which there is minimal strength loss making design still optimal for use
- Hypothesis:
  - We predict that as more aluminum corrodes there will be a decrease in the EI constant and bulk modulus.



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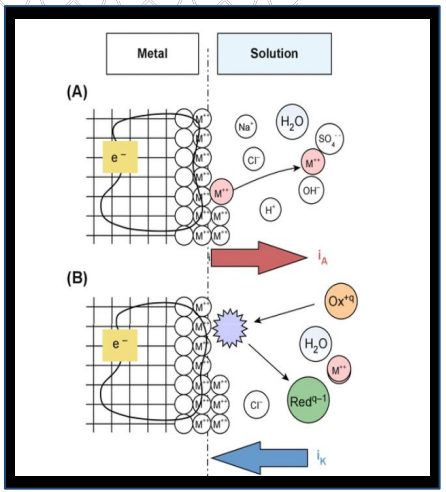
Theory and Experimental/Setup

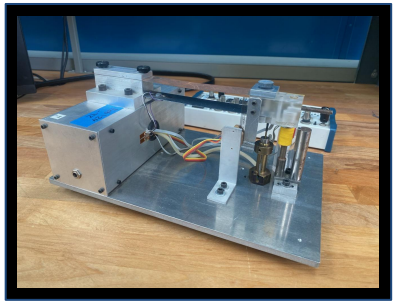
Theory

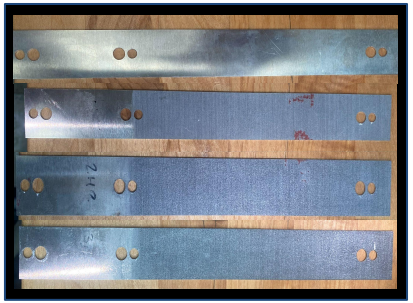
- Why does corrosion happen?
  - Electrochemical reaction between a metal and its surroundings.
- How does corrosion happen?
  - Anodic current and cathodic current via oxidation and reduction, respectively.
- What effect will this have on the material properties and how will they be measured?
  - Flexural Rigidity and Bulk Modulus measured by vibrational beam setup from Lab 3



Experimental/Setup

- Used the vibrating beam set up from Lab Natural Frequency of a vibrating beam
- Corrosion solution (NaCl, Hydrogen Peroxide, White Vinegar)
- Fabricated four Aluminium 6061-T4 samples using laser cutter at Jacobs





Results

Calibration Method

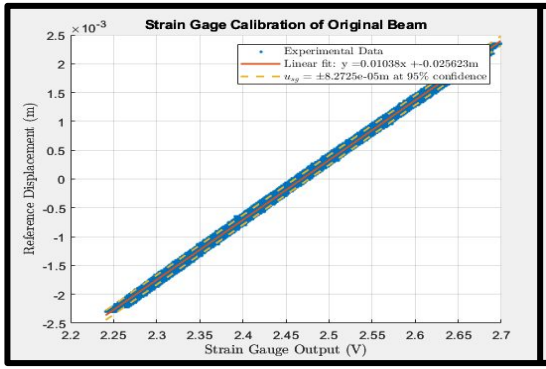
- Applied polyfit and polyval in the MATLAB code
- Increased the number of spans which make the data go smoothly during calibration

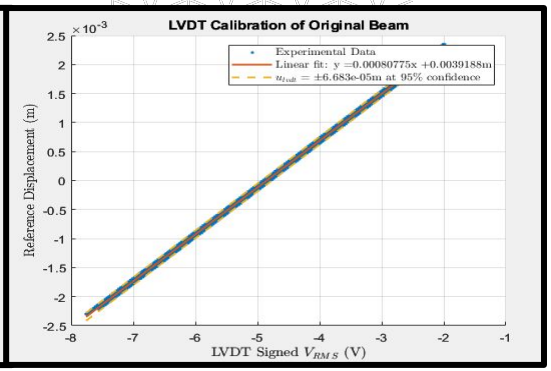
Determine the Maximum Values and The Uncertainty

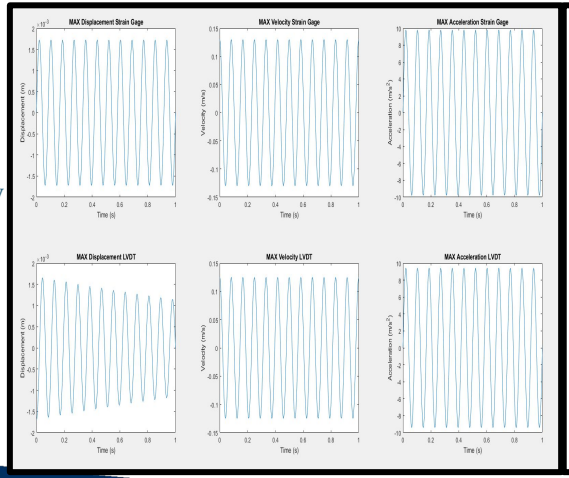
- Used equation of sinusoidal sin(t) = sin(2*pi*fn*t)
- Took derivative twice from the equation sinusoidal waveform(displacement->velocity->acceleration)
- Used Uncertainty propagation to determine the uncertainty
- of Maximum values

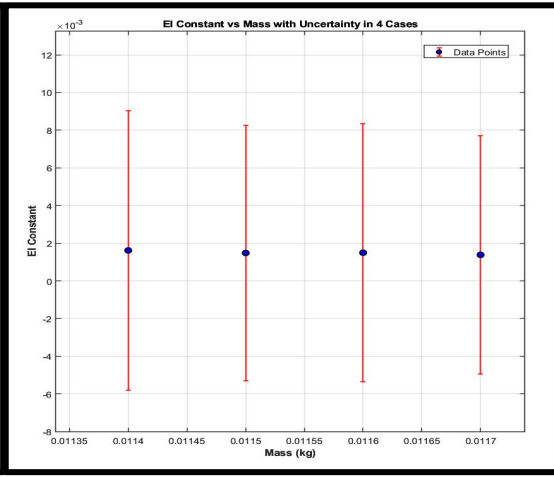
Determine the Value of EI Constant and its uncertainty

- Used formula of the deflection of the beam in case of cantilever beam
- Used Uncertainty propagation to determine the uncertainty EI constant









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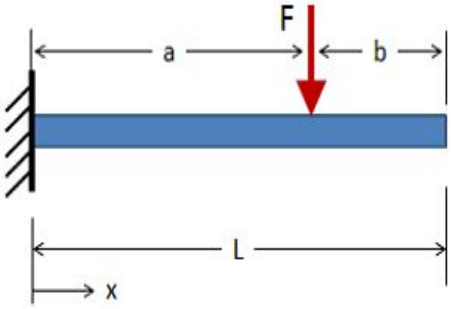
Discussion/Conclusion

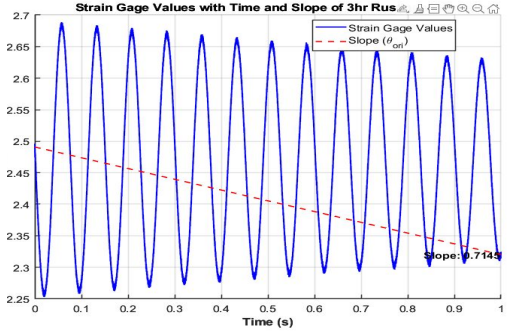
Discussion

- Applying Cantilever beam problem with F acting
- Determined the deflection
- Slope of the Strain Gage from three hours of corroding beam
- Determined Bulk Modulus(K)

Conclusion

- Some constraints & Uncertainty
- Succeed to investigate how EI constant, K change, and corrosion affects
- Changing slope, indicating damage & degradation in the beam after corroding for hours
- Beams loses its stiffness, creates more oscillations which indicates higher damping





$$K_{corrosion} = \frac{F}{y} = \left(\frac{mg}{\frac{mgL^3}{3EI}}\right) = \frac{3EI}{L^3}\ (N/m),$$

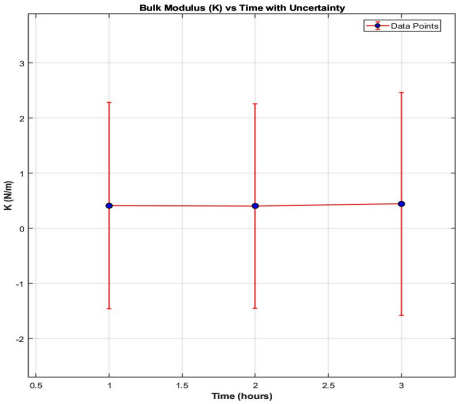
,where $K_{corrosion}$ is Bulk modulus after corroding.

Percentage of corrosion is 5% = 0.05

The K is being affected by the corrosion, which can be determined by

$$Corrosion\ contribution = \frac{K_{corrosion} * V_{corrosion} * 0.05}{V_{total}}\ (N/m),$$

Type of bulk modulus	K for one hour	K for two hours	K for three hours
Values of Bulk modulus and its uncertainty(N/m)	0.4084 ± 0.1871	0.4049 ± 0.1855	0.4415±0.2024
Corrosion contribution(N/m)	0.0204	0.0202	0.0221



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Contributions

Contributions -

- Andy Ho
  - Data collection, methods section, helped with equipment/experiment slides and formatting,
- Phuoc Nguyen
  - Data analysis, MATLAB code, Results/ Discussion
- Jarred Sitton
  - Abstract, Introduction, Analyzed similar experiments
- Eric Bermudez
  - Theory, corrosion research, facilitated metal corrosion, data collection
- Peter Bhatta
  - Designed/Manufactured custom hardware, data collection, methods section

References

References

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Requirements link (3-4 slides)

Introduction
- Why you're doing measurements
- General scope of experiments
- Your hypothesis

Theory
What do you use to compare with experiments?
Equations, graph, etc.
can take whole page for section if extensive, but goal is to just give basic overview with a few equations and graph

Experimental Setup/Methods
How did you run your experiment?
What sensors did you use?
Show diagram/photos!

Results
Show the results!
Compare with theory here or in discussion
Some raw and the most important final results
Prepare us to draw a conclusion on the next slide

Discussion/Conclusion
Compare with theory
What did we learn?
Did the measurements work?
If not, what was the issue? Uncertainty?
Discuss implications & what you'd change

Corrosive Effects on Material Constants in Aluminium 6061-T4

Introduction:

Objective: Explore the impact of corrosion on flexural rigidity(EI) and bulk modulus(K) of aluminum-6061-T4.
Purpose: Enables the development of more robust designs that consider the reduction in strength due to corrosion.
Hypothesis: As more aluminum corrodes there will be a decrease in the EI constant and bulk modulus.

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