Contract No:

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Disclaimer:

Determination of Ligament Quality Factors in Additively Manufactured Lattice Structures Using In-Situ Compression Testing Micro-CT

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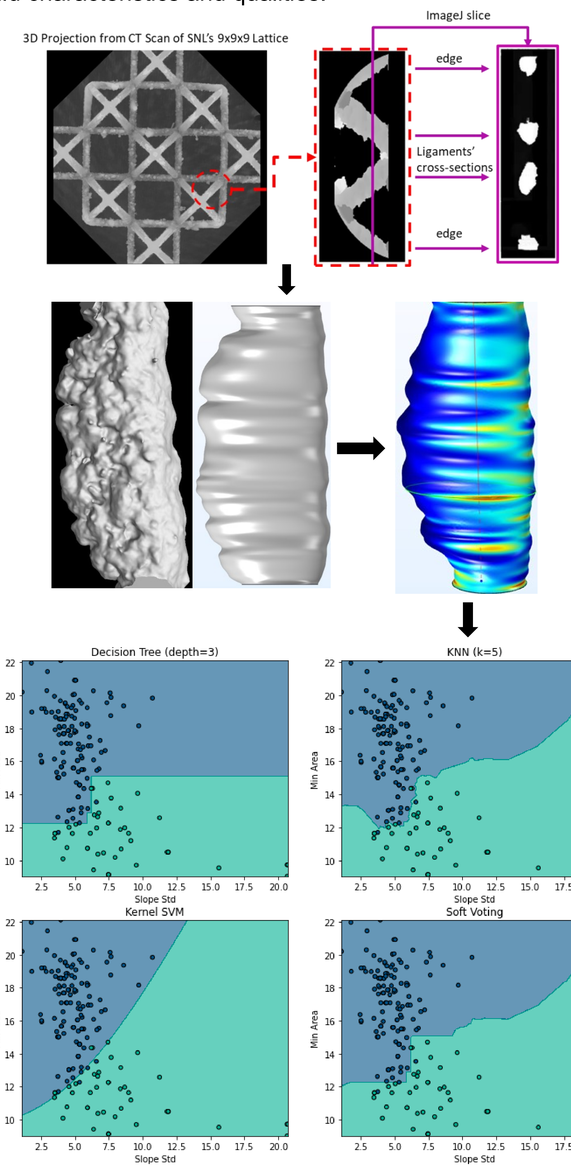
Savannah River National Laboratory®

Motivation and Previous Work

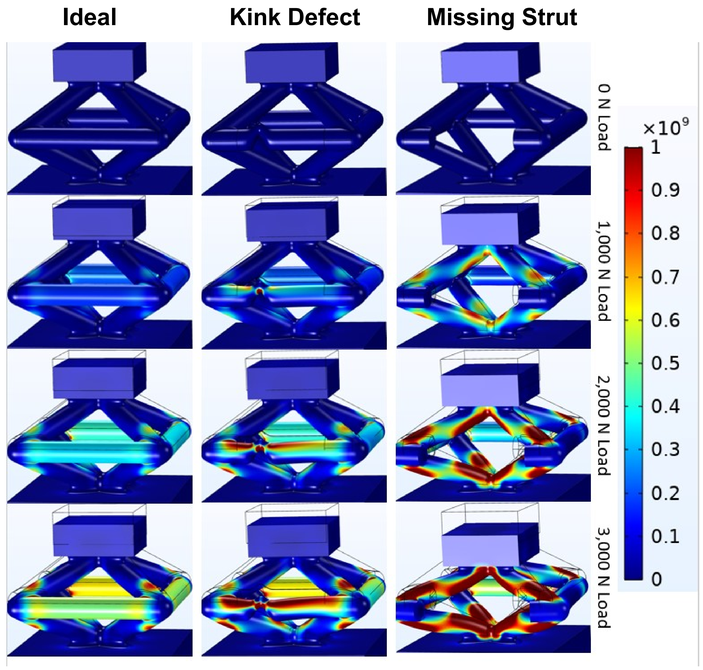
How do we qualify complex additively manufactured parts?

- No ASTM standard on production of AM parts exists
- Automated, commercial method to extract global and local information from a CT scan of an AM lattice component is needed
- Savannah River National Laboratory (SRNL) developed a software package that can automatically review a CT scan of a lattice and extract information (angles, lengths, diameters as a function of lengths, anomalies, etc.).
- The information extracted can be used in Finite Element analysis to better understand build quality, be related back to build properties, and be used in machine learning algorithms to predict build characteristics and qualities.



Defect Compression Simulations

- 0kN, 1kN, 2kN, and 3kN compressive loads were applied to:

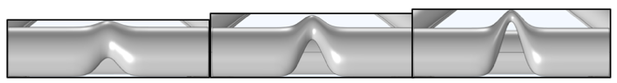


Lattice Defect Types

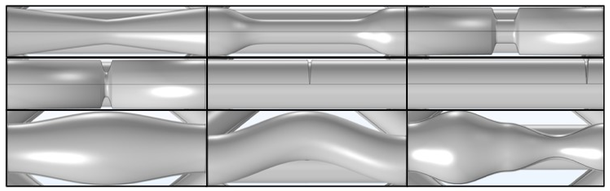
How do we measure the effect of lattice defects?

- Create unit cells with 1 defective strut

Evolution of Defect Magnitude – 25, 50, 75% Diameter



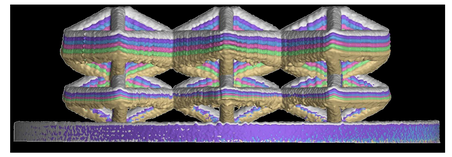
Additional Defects at 50% Magnitude



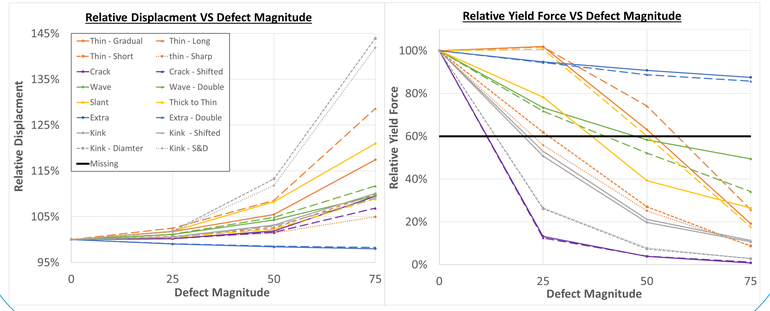
- Simulate special cases of thinning, excess material, waviness, cracks, and kinks were simulated
  - Use representative defects observed from previous studies

Results

- Sandia National Laboratory (SNL) performed studies on ideal lattices



- Simulated results show that defects in the struts can have a large impact on the yield strength



Future Work

- Validate simulation results with Deben CT5000RT
  - 256 total samples built for statistical analysis
- Use results to:
  - Generate digital twins from FEA analysis
  - Provide Machine Learning training data

References

1. A. Dressler, E. Jost, J. Miers, D. Moore, C. Seepersad and B. Boyce, "Heterogeneities Dominate Mechanical Performance of Additively Manufactured Metal Lattice Struts," *Additive Manufufacturing,* 2019.
2. A. Garland, B. White, B. Jared, M. Heiden, E. Donahue and B. Boyce, "Deep Convolutional Neural Networks as a Rapid Screening Tool for Complex Additively Manufactured Structures," *Additive Manufacturing,* vol. 35, 2020.
3. E. Jost, D. Moore and C. Saldana, "Evolution of global and local deformation in additively manufactured octet truss lattice structures," *Additive Manufacturing Letters,* vol. 1, 2021.

Acknowledgments

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