3D Printed Wing Tip End Cap

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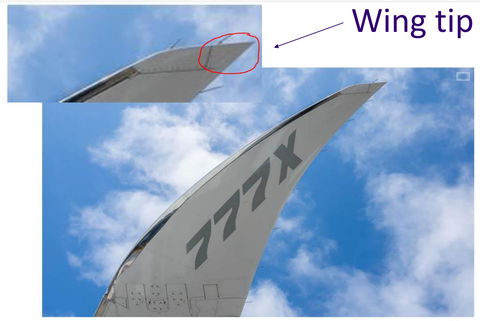
INTRODUCTION

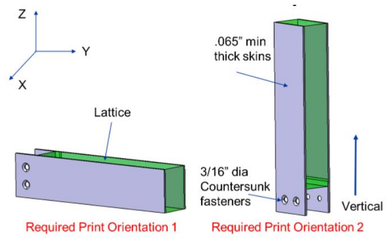
- *Laser Powder Bed Fusion 3D Printing:* allows for complex and innovative structures.
- Modern commercial airplane wings are integrating a *wing tip* to minimize the amount of wing tip vortices (mass of whirling air).



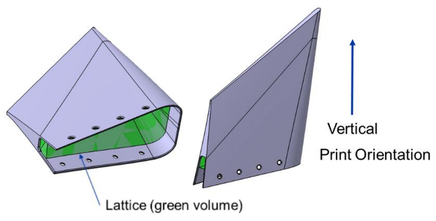
DESIGN OBJECTIVES & BREAKDOWN

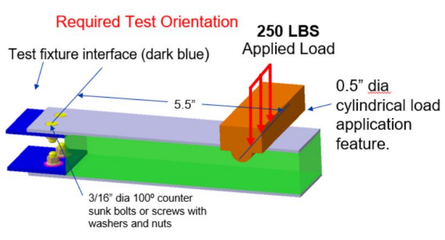
- *GOAL: Design a metallic lattice to fill a cantilever coupon AND a 3D printed wing tip.*
- Coupons must be printed in H and V directions.
- Coupons must withstand 250 lb load with max deflection of 0.019 in.
- Final wing tip must withstand applied 500 lb load.

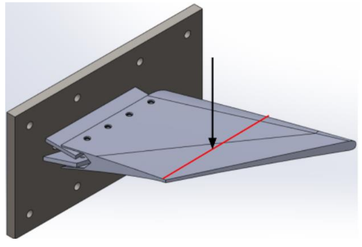
Phase 1: Cantilever Test Coupons



Phase 2: Wing tip End Cap







LATTICE DESIGN

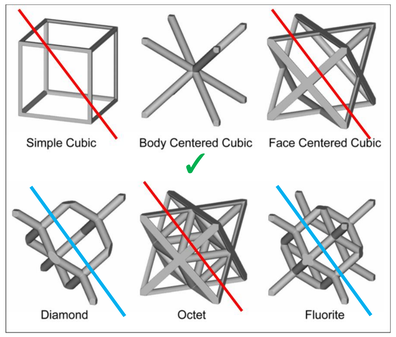


Figure 1: different types of lattice structures

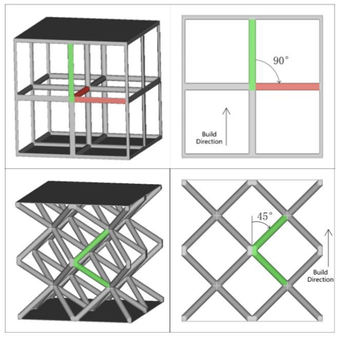
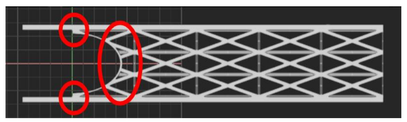


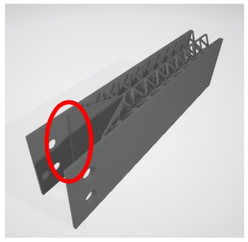
Figure 2: the importance of a 45° lattice angle

- Red strikethroughs would have issues 3D printing due to overhang as shown in Figure 2.
- Blue strikethroughs can be printed, but are complex and not material efficient.
- Final Lattice: BCC (simple, strong and easy to print)

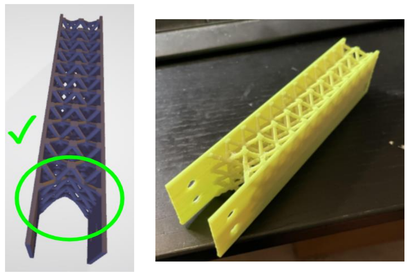
PRELIMINARY FDM PROTOTYPES



"Arch" coupon



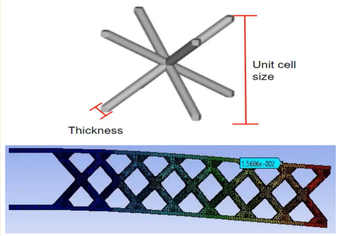
"Tri" coupon



Final Design: "Triangle Cut"

- Our first design, an "Arch" coupon, has overhang issues in the middle and on the sides.
- Our next design, a "Tri" coupon, has no overhang in the middle but still has it on the sides.
- Our final design, a "Triangle Cut", uses the 45° nature of the BCC. The coupon has no overhang and is material efficient.

PROJECT RESULTS



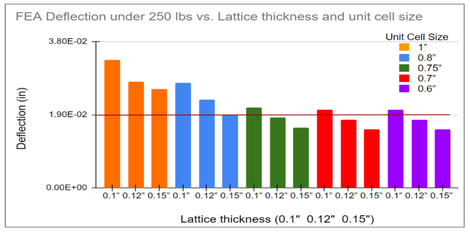


Figure 3: ANSYS FEA data for different lattice thicknesses

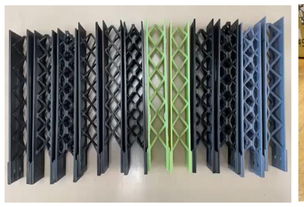


Figure 4: plastic coupons for testing

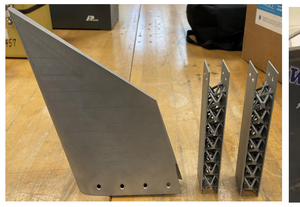


Figure 5: final ordered aluminum parts

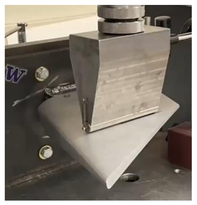


Figure 6: testing setup

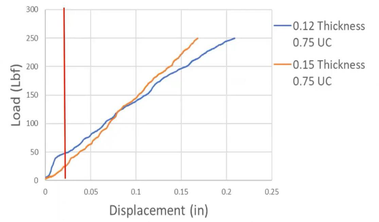


Figure 7: metal coupon test data

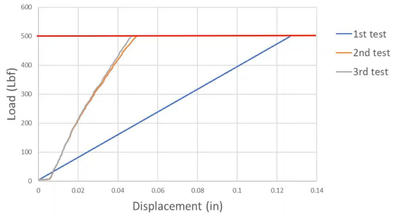


Figure 8: metal wing tip test data

- Based on FEA & testing data on plastic coupons, we printed a 0.15in thick lattice in the wing tip, and two coupons with 0.15in & 0.12in thick lattices. All three parts were printed in aluminum and had a 0.75 unit lattice.
- The 0.15in thick metal coupon and the final wing tip met the project requirements.

CONCLUSIONS & FUTURE WORK

- Our lattice was very strong and cost efficient.
- Managing the deflection of our testing fixture was very difficult.
- For the future, we would more closely monitor surrounding deflections of our testing setup for more accurate results using more strain gauges and close video footage.

Acknowledgements

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Mechanical Engineering Capstone Exposition

June 2nd 2022, Husky Union Building, University of Washington, Seattle