An initial study on the line orientation patterns of a 3D printed specimen and its resistance to stress placed onto a specimen

Effects of Line Orientation Pattern on the Open Hole Tensile Properties of a 3D Printed Composite

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Introduction

- In 3D printing, parts are made by tracing lines one layer at a time and the direction of the lines relative to the loading direction can affect the strength of the specimen.
- Similar studies that are testing the properties of tensile stiffness and strength have been conducted by undergraduates in Dr. Nicholas Smith's lab.
- Christopher Rogers studied similar 3D printed specimens with a newly programmed line orientation pattern. [1]
- Our study compares the effects that the line orientation pattern has on the resistance to a stress placed on a printed specimen.

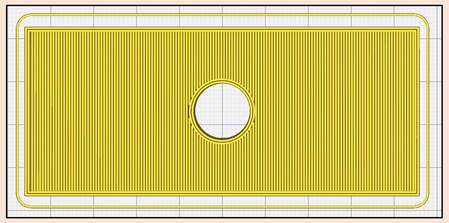


Figure: Geometry code from Cura software of vertical linear orientation for a specimen.

Hypothesis and Rationale

- **Purpose**: Determine the best line orientation pattern and material for a printed 3D specimen to reduce the stress being applied.
- Our hypothesis is that the 3D-printed specimen that is made from CF-PLA (Carbon Fiber - Plastic) material and has parallel line patterns aligned with the loading will be more resistant to any tensile stress placed onto the specimen.
- Our null hypothesis is that the 3D-printed specimen that is made from PLA (Plastic) material and has vertical line patterns aligned with the loading will be more resistant to any tensile stress placed onto the specimen.

Materials and Methods

- This study uses two types of plastic when printing such as PLA (Plastic) and CF-PLA (Carbon Fiber).
- The tensile stiffness and strain of the specimen were tested using a Tensile Test machine.

Tensile Test Machine

Results

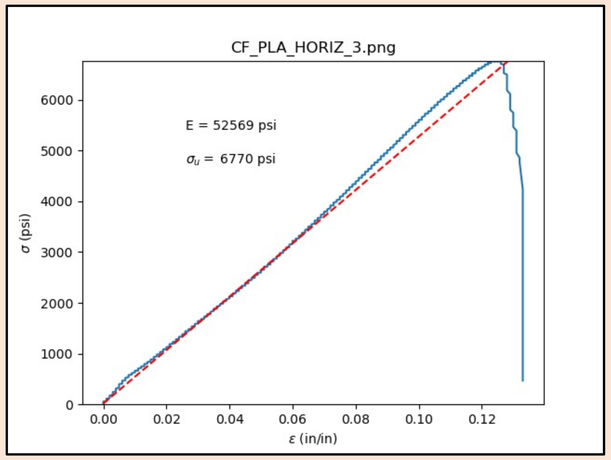


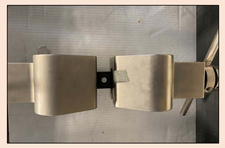
Figure: Stress vs Strain graph shows the total strength and stress resistance of a specimen before breaking. Stiffness (E) value comes from the slope of the red dashed line. Ultimate strength (σu) is the maximum stress of the specimen shown by the maximum point of the blue curve.

Conclusions

PLA, Hori. Line Orientation		CF-PLA, Hori. Line Orientation	
Stiffness (psi)	Ultimate Strength (psi)	Stiffness (psi)	Ultimate Strength (psi)
52364	7203	52638	6705
PLA, Vert. Line Orientation		**CF-PLA, Vert. Line Orientation**	
Stiffness (psi)	Ultimate Strength (psi)	Stiffness (psi)	Ultimate Strength (psi)
37487	2001	43235	2946

- **Table**: Shows the average results of the stiffness and ultimate strength values for the vertical and horizontal line orientations with either PLA or CF-PLA.
- The conducted study concludes that the horizontal line orientation pattern with CF-PLA material is the most resistant to stress placed on a specimen.
- One of the limitations in the study was that the specimens were printed without a clamping area to hold on to the Tensile Test Machine.

Future Directions



- To investigate a new line orientation pattern developed by a graduate student.
- Making our prints with a clamping area so that the machine has more grip onto the specimen and is less likely to fail at these ends.

References

1. Christopher Rogers, AN ALGORITHM FOR DIRECTIONALLY TAILORED TOOLPATH GENERATION FOR FUSED DEPOSITION MODELING, pg. 1-51

Acknowledgements

Christopher Rogers