CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

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Project Number

J0314

Project Title

Make It or Break It: How Do Different Filaments and Fill Patterns Affect the Strength of a 3D Printed Object?

Abstract

Objectives/Goals

This project's objective is to compare the strengths of 3D printer plastics and internal structures under a variety of stresses: shear, torsion, flexure, and tension.

Methods/Materials

Using a Solidoodle 2 Pro 3D printer, I created hundreds of rectangular prisms using PLA and ABS printer filaments, and for each of those plastics, the objects' internal structure (of 20% density) was honeycomb, rectilinear, or linear. Using clamps and simple wood test devices, I applied flexure, shear, torsion, and tension stresses to each of the objects and recorded the maximum reading from the fish scale I used to apply the force to the objects.

Results

The results showed that for both plastics, the honeycomb pattern was able to withstand greater forces than the linear and rectilinear. The experiment also found that PLA filament consistently withstood greater forces than ABS. The prints made with PLA filament with the honeycomb fill pattern were stronger than prints made with other fill patters, except for ABS, with its linear structure being slightly stronger in my flexure tests.

Conclusions/Discussion

This examination of the behavior of two different 3D printer plastic filaments and three different fill patterns when under a variety of stresses demonstrated that - even when the amount of plastic used in the object's fill is of the same density - a honeycomb pattern tends to provide the greatest strength. Limitations of the software I used for printing - Slic3r and Repetier Host - did not allow it, but I would have liked to try a triangular fill pattern, because I think that would be even stronger than the others. Also, I was gratified to find that the biodegradable PLA plastic actually proved generally stronger than the recyclable but not biodegradable ABS plastic.

Summary Statement

My project investigates how different 3D printing plastics and fill patterns stand up to a variety of forces.

Help Received

Dr. Daniel Fernandez, CSUMB, for asking the question of this project; my father cut parts for my test devices and ran the 3D printer; Mr. William, OSH, for suggestions in designing test devices; Mr. Richard Herbert for the suggestion of a fish scale.