Strength Optimization of 3D Printed Wind Turbine base

Jessy Chavez Bianca Quintana

Introduction

- **3D Printing**

3D printing is used to replicate three-dimensional objects form a 3D model or sketch , out of ABS material.

- **ABS Material**

  ABS is the main plastic of choice for 3D Printers, as the printed parts are tough and durable. The parts are made out of the same plastic as Legos.

- **Support Material**

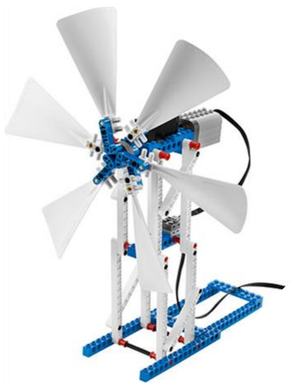
  When working with three dimensions, you have to deal with gravity. As a part is being printed one layer at a time, something needs to hold layers in place and keep the base from falling apart, which would be support material.

- **Cleaning**

  When using support material liquid baths are commonly used, that contain Sodium hydroxide, a corrosive that removes support material only.

- **DOE (Design Of Experiments)**
- Used to find out which inputs have a significant impact on the output.
- Also what the best level of these inputs should be to achieve better results.
- Design of Experiments are also powerful tools used to achieve cost savings by minimizing process variation and reducing retrial, waste, and the need for inspection.
- Randomization was used to have a different trials to avoid any patterns that might lead to errors.
- Replication was also used to have retrial to find more of a closed range of results.

Lego Model



Objectives

- To find how different factors impact the base part.
- To maximize our strength while keeping it lightweight.
- Test which factors are the best to use using DEO method.
- To make a proper comparison between a Lego model and a 3D printed model while optimizing for strength and cost.
- The objective of this research is to improve the Lego parts for a wind turbine base using 3D Printed Legos. The goal is to create /find which part is more stronger while minimize the cost as much as possible.

Methodology

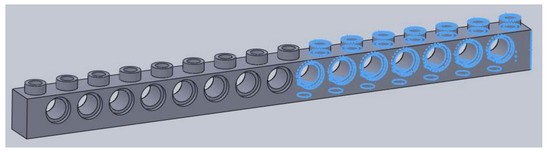
- **Layer resolution**: Refers to the thickness of each printed layer.
- **Model interior**: Refers to how the material inside each part is .
- **Support fill:** Refers to what hold the model during the printing process.

StdOrder	RunOrder	CenterPt	Blocks	Model Interior	Support Fill	Layer Resolution
13	1	1	1	Sparse Low Density	Basid	0.330
9	2	1	1	Sparse Low Density	Basid	0.254
8	3	1	1	Solid	Surround	0.330
7	4	1	1	Sparse Low Density	Surround	0.330
1	5	1	1	Sparse Low Density	Basid	0.254
3	6	1	1	Sparse Low Density	Surround	0.254
12	7	1	1	Solid	Surround	0.254
14	8	1	1	Solid	Basid	0.330
2	9	1	1	Solid	Basid	0.254
16	10	1	1	Solid	Surround	0.330
5	11	1	1	Sparse Low Density	Basid	0.330
11	12	1	1	Sparse Low Density	Surround	0.254
6	13	1	1	Solid	Basid	0.330
10	14	1	1	Solid	Basid	0.254
15	15	1	1	Sparse Low Density	Surround	0.330
4	16	1	1	Solid	Surround	0.254

Steps to preform the research

1. Measure all dimensions in the Lego part using a Digital Caliper.

2. Create 3D module of the Lego part using Solid Works.



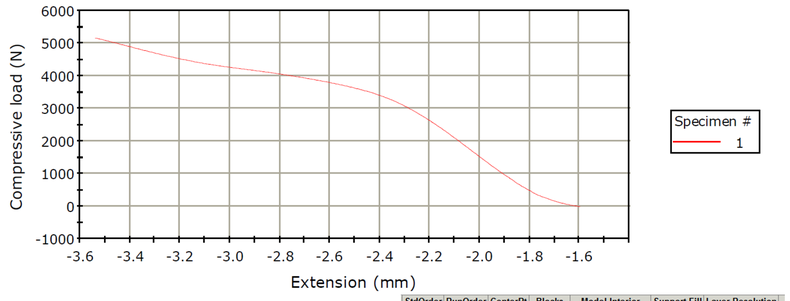
3. Print the parts using the Uprint 3D printer. Print them according to the factors and clean them with sodium hydroxide

Testing

1. Place part on machine and wait for it to be compressed/tested and to get results.

Results

Data collected:



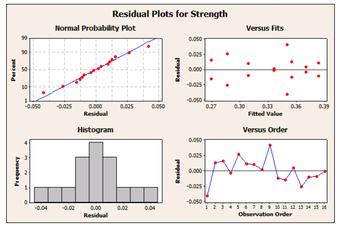
Compressive stress at Break (Standard) (MPa)
0.39374

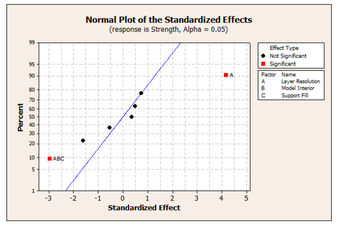
Mega Pascal- Unit of pressure

StdOrder	RunOrder	CenterPt	Blocks	Model Interior	Support Fill	Layer Resolution
13	1	1	1	Sparse Low Density	Basid	0.330
9	2	1	1	Sparse Low Density	Basid	0.254
8	3	1	1	Solid	Surround	0.330
7	4	1	1	Sparse Low Density	Surround	0.330
1	5	1	1	Sparse Low Density	Basid	0.254
3	6	1	1	Sparse Low Density	Surround	0.254
12	7	1	1	Solid	Surround	0.254
14	8	1	1	Solid	Basid	0.330
2	9	1	1	Solid	Basid	0.254
16	10	1	1	Solid	Surround	0.330
5	11	1	1	Sparse Low Density	Basid	0.330
11	12	1	1	Sparse Low Density	Surround	0.254
6	13	1	1	Solid	Basid	0.330
10	14	1	1	Solid	Basid	0.254
15	15	1	1	Sparse Low Density	Surround	0.330
4	16	1	1	Solid	Surround	0.254

- **Strength**:

Using a significance level of 0.05, it can be concluded that the data is normally distributed and there is randomness. The significant factors are: Model interior and Layer resolution.





Conclusion:

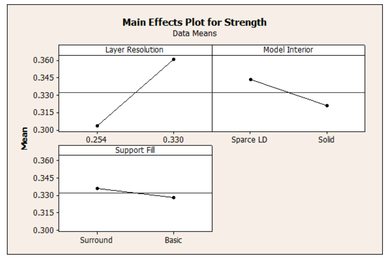
It can be concluded that Cost and strength can be decreased and increased correspondingly using 3D printing. Additionally, we can conclude that weight does not change significantly when using different factors of this technology.

The optimal combination in order to obtain high strength and low cost.

Model interior: Sparse Low Density

Support Fill: Surround

Layer resolution: .330



Acknowledgments

Dr. Psu Hsu, Dr. Bill Tseng, Aditya Akundi, Juan Saavedra, Cristian Lopez and David Explain