Materialistic Efficiency of PLA in 3D Printing

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INTRODUCTION

There are many different variables in 3D printing such as the size of the object, the material used, the density of the printed object, and other variables that must be accounted for when 3D printing an object for daily use. This poster focuses on determining the materialistic efficiency of PLA in 3D printing.

Abstract

Three-dimensional printing is the process of extruding a material layer by layer to produce a three-dimensional object. This technology has a variety of applications from creating lab equipment to making houses. The goal of our research was to find the most efficient use of material in three-dimensional printing. To do so, the fill density of a rectangular beam was varied, then the spring constant of these beams was determined and compared to what should theoretically occur. This optimal percent fill would be the point in which the least amount of material would be used to maintain the greatest spring constant and would be the most efficient for industrial applications. A graph was created that plotted the determined spring constant versus the percent fill to find an optimal fill percentage. This would occur at the lowest percent fill where the change in the spring constant became the smallest.

OBJECTIVES

- Determine an optimum percent fill for a 3D printed beam
- Compare the theoretically calculated deflection with the experimental data
- Examine the efficiency of PLA in 3D printing

METHODS

- Theoretically determine the spring constant of a 3D printed beam at variable infill densities
- Determine an appropriate force for a measurable displacement curve
- 3D print beams with consistent dimensions with variable infill percentages
- Test printed beams with predetermined force
- Examine theoretical and actual data

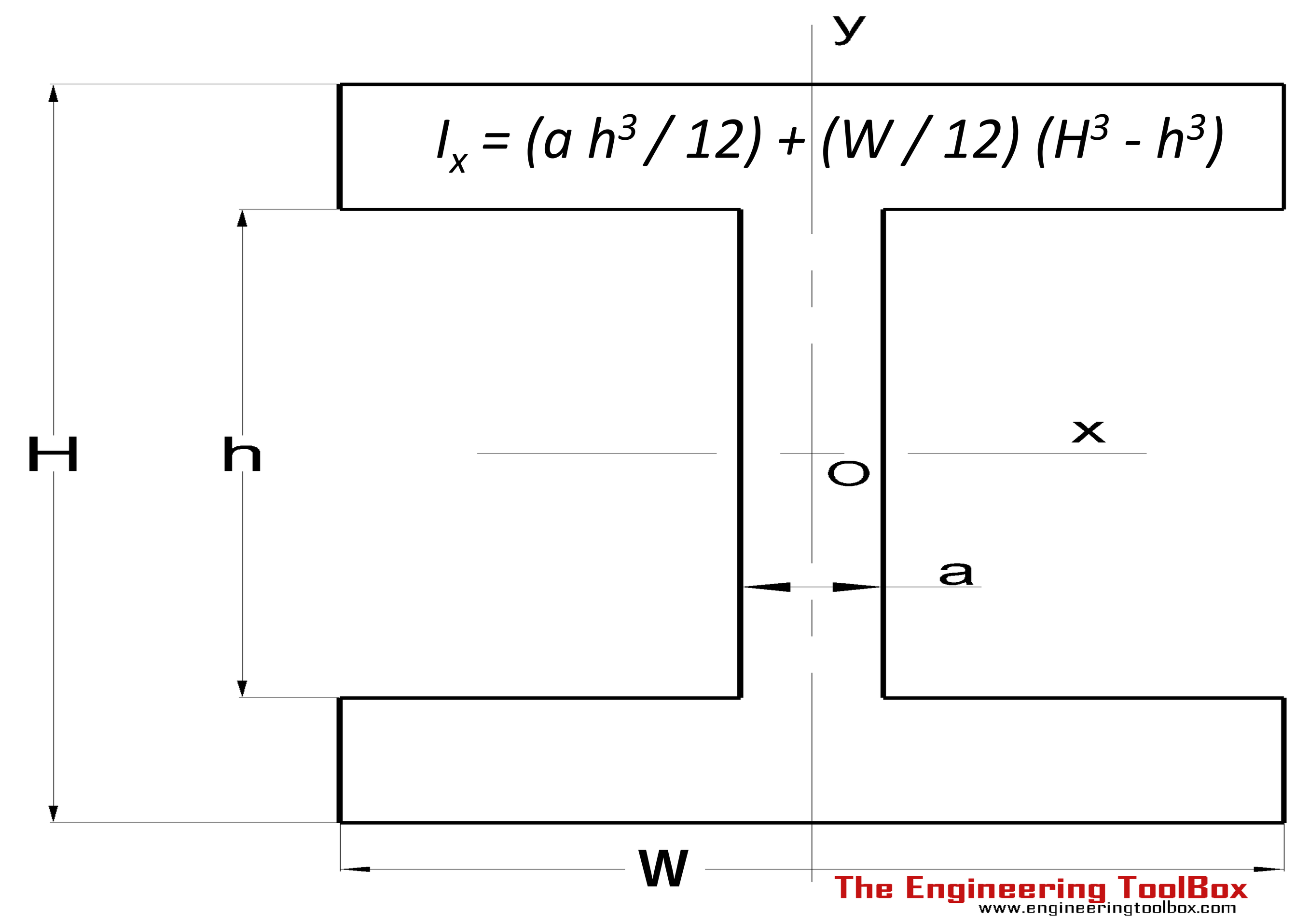

Figure 1. Moment of inertia formula used to determine the spring constant of a symmetrical beam

$$k_{cantilever} = \frac{3EI}{L^3} = \frac{EWH^3}{4L^3}$$

RESULTS

- The measured deflection did not match the calculated deflection for a symmetrical beam under a certain force
- The optimum percent fill, and the most materialistic efficient point would occur when the change in the slope of the line of best fit is at its lowest value.
- Variables in 3D printing that cannot be accounted for in theoretical calculations

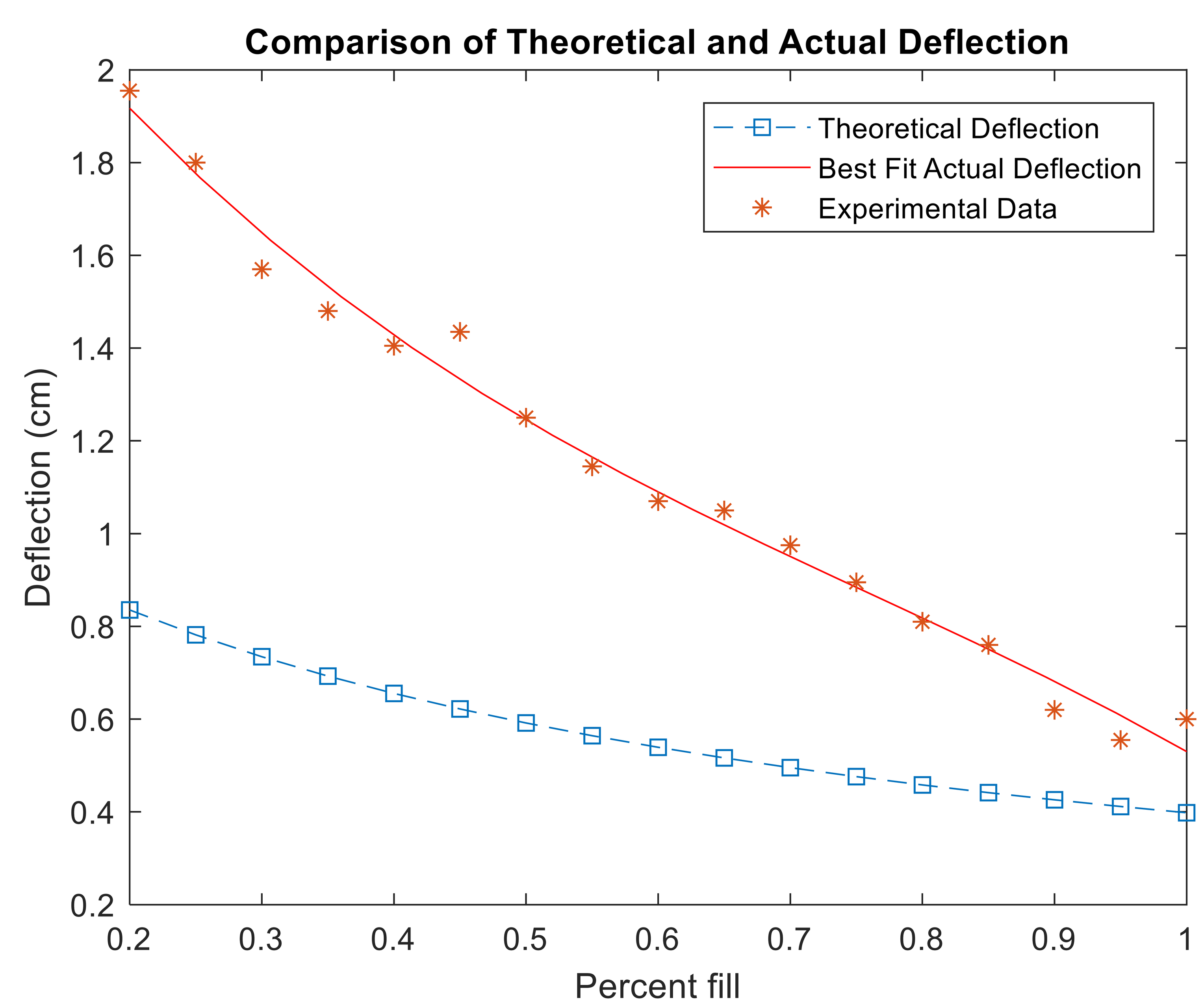

Figure 2. Comparison of Theoretically Calculated Deflection and Experimental Deflection

CONCLUSIONS

The theoretical calculation method used was not efficient in approximating the deflection of a 3D printed beam. Despite this, through experimental testing, the optimum percent fill was able to be determined. This would occur where the change in the slope became minimal. This occurred at approximately a 76% fill. This percent fill would be the most efficient use of material and the point where the least amount of material was used to maintain the greatest spring constant.

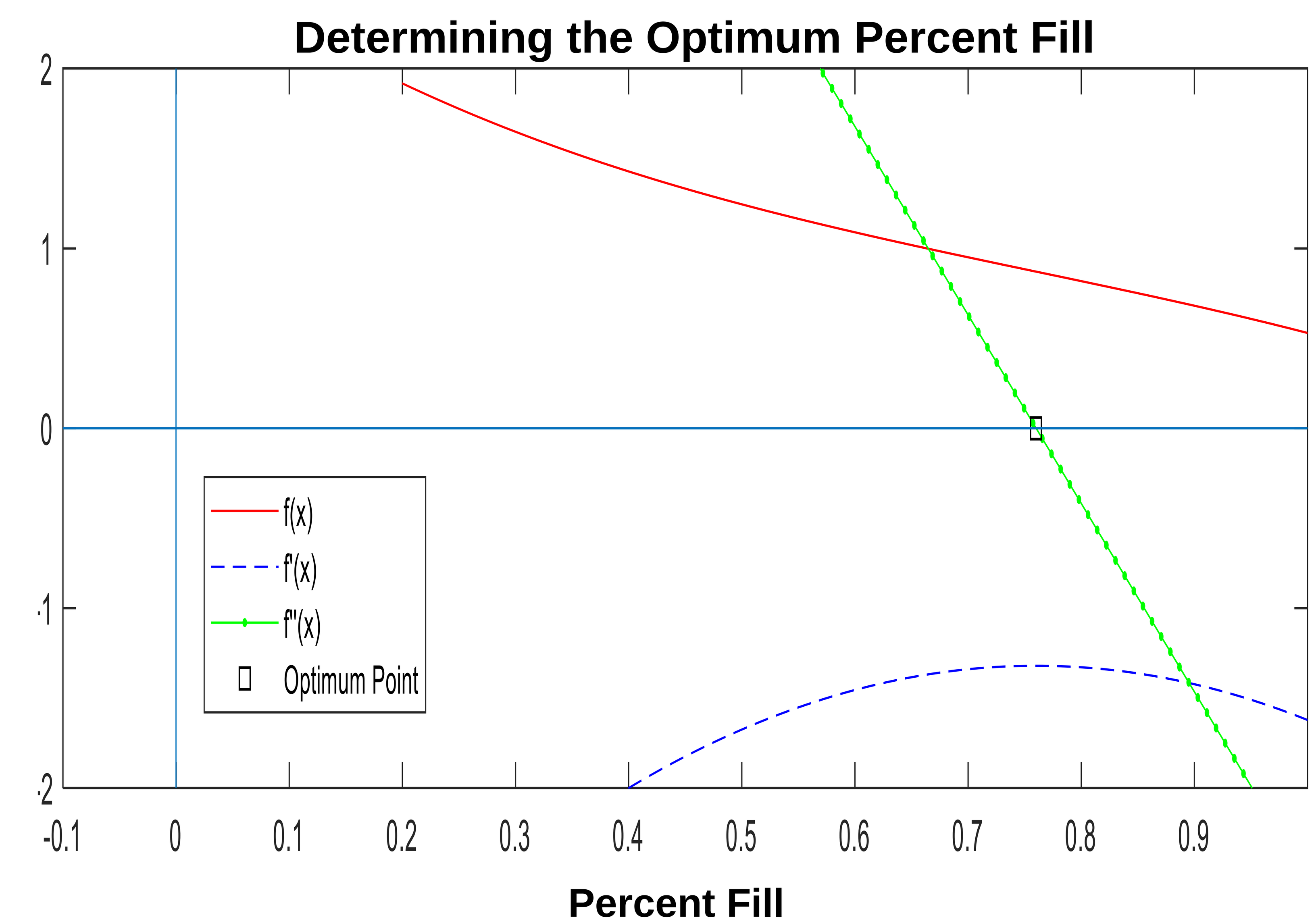

Figure 3. Determining the Optimum Percent Fill
Note: f(x) is the best fit line of the experimental data

FUTURE WORK

- More testing at varying dimensions to see if the experimental deflection can be measured using an equation
- Test other materials that can be used to 3D print beams and examine the relationship between the strength of the material and the deflection observed

References

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