Abstract

The effect of simple I-beam dimensions on maximizing failure load while minimizing mass was analyzed through the use of SolidWorks simulation software. Physical testing was attempted, but determined to be too inaccurate to generate reasonable results. A full factorial model was generated, and analysis of the results showed that overall beam width was the strongest factor in both mass and bearing load responses. It was found that minimizing the width and length of the central portion of the beam, while keeping beam width at a value approaching the middle of a selected range, was ideal for minimizing mass while maximizing failure load.

Conclusion

Ultimately, the beam elements that had the strongest response with regards to minimized mass and maximized failure load were the overall beam width, followed by the beam length of the central portion of the beam. When considering rational value ranges or the three factors, this result is reasonable. The beam height being minimized was expected, but the beam width having a middling value within the selected range was interesting. The width of the beam has the largest impact on mass, so minimizing it would be ideal. However, a larger width would increase the beam top surface area, allowing for lower stress when a force is applied. Thus the beam width must be balanced depending on whether a larger weight is placed on minimizing mass or maximizing failure load.

The range of values used could have been increased to push the limits of rational parameters, but the results determined a reasonable result. Minimizing the width of the central portion further would not have been feasible, as the beam would likely bend out of plane. In addition, when 3D printing, time and space with the printers was limited. The amount of force required to cause failure in the beams was at minimum and order of magnitude larger than expected. The physical experiment could be adjusted to account for this by reducing the beam factor range by a certain percentage, and larger forces being applied to the beam could be more accurately determined through the use of a force gauge, which was unavailable at the time of the experiment.