INTRODUCTION

The objective of this research project was to design, model, and manufacture a 1.7m column made of 3D printed steel that would support a large monitor. The column had to be both structurally stable and aesthetically pleasing. Side investigations included model optimization, tensile tests of 3D printed steel, and welding parameterization.

MODEL OPTIMIZATION

The first step was sketching a design and basic computations. The calculations included expected mass and bending moments from somebody “teasing” on the monitor.

The second step involved parameterization in both Matlab and Grasshopper so that many iterations of Rhino models could be made. In this stage designs were eliminated based on aesthetic and base plate limitations. Any angle of convergence more than 10 degrees was determined unrealistic.

The third step involved putting dozens of designs into ANSYS Workbench 18.2 for finite element analysis. The designs were altered to reduce maximum deformation until below 5mm. This was done by increasing the radii of the ellipses, and coding the converged clover to grow with increasing length. This proved to be nerve racking because it is by far the most difficult section to manufacture.

TESTING

The average yield stress was 329 Mpa, and the test demonstrated a high porosity.

The success of the CMT welding process is dependent on numerous welding parameters such as wire size, wire feed rate, welding speed, choice of shielding gas, shielding gas flow rate, power, arc length, and torch position. Both the wire size and the shielding gas choice were constant because there was only one type available. The wire diameter was 1.2 mm and it was made out of steel. The shielding gas was Arcox 18, which is 82% Argon and 18% carbon dioxide. When welding steel, it is important to have an active gas like carbon dioxide. Other parameters—like shielding gas flow rate, power, arc length, and torch position—were kept constant to keep from complicating the experiment. The shielding gas flow rate was 11 L/min, the power was 1.0 Watts, the arc length was 2.0 units¹, and the torch position was vertical. Wire feed speed (layer thickness) and welding speed were varied to observe print quality. The second test was still speed variation; however, this time the location of the speed shift was also studied. Changing speeds leads to uneven layers, which eventually results in the wire electrode being too close and too far in one cycle. It proved benefical to print at 330 mm/min and make minimal changes. The third test studied changing the layer thickness by changing the wire feed speed at a constant welding speed of 330 mm/min. The layer thickness started at 1.2mm and was increased to 1.5mm. The piece experienced material overflow because the thicker layer had nowhere to go when printed onto the thinner layers. The next test corrected this process by instead changing the layer thickness—1 mm at a time. The final test on a single ellipse was done with a wire feed rate of 2.6 m/min, layer thickness of 1.4mm, and welding speed of 330 mm/min. It was successful until roughly 25 cm where the heat of the piece built up and the top melted. Single ellipse tests, while not a perfect representation of the final design, were useful for understanding the effects of changing certain printing parameters.

CONCLUSIONS

3D printing may be the way of the future, but because of the large amount of time it takes to print, it will most likely remain on a small scale. This summer’s research concluded that even the best printers cannot match the speed of mainstream manufactured steel; however, 3D printing steel is great for smaller projects.

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