OPTIMIZING SUPPORT STRUCTURES FOR CYLINDRICAL GEOMETRIES: A PERFORMANCE EVALUATION

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Abstract: In this work, a thin-walled cylindrical AlSi10Mg model created by Selective Laser Melting utilizing Simufact Additive is compared using line, contour, and block supports. According to the data, block support has the lowest displacement (0.74 mm), the lowest surface deviation (0.34 mm), and 81% tolerance compliance. It offers the best balance between structural stability and dimensional precision, albeit having a slightly longer build time.

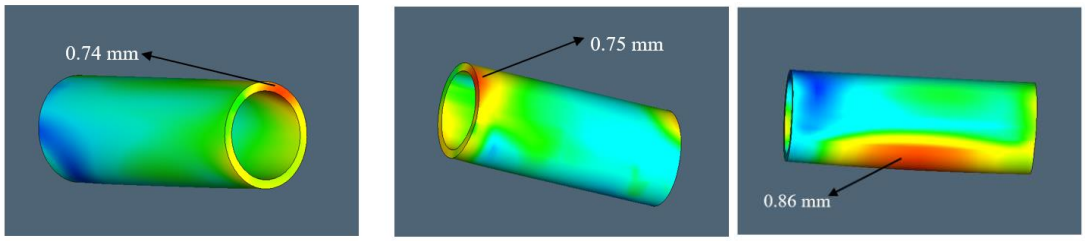
Keywords: Additive, support, displacement, equivalent stress, surface deviation

INTRODOCTION

Complex metal items with excellent mechanical qualities and great dimensional precision are frequently produced using additive manufacturing, particularly Selective Laser Melting (SLM) [1-2]. However, the design of the support structure has a significant impact on the quality of manufactured parts. This is especially crucial for cylindrical geometries because overhangs and curved surfaces can exacerbate surface flaws, residual stress, and deformation [3]. Support structures must therefore be assessed in terms of end part quality, build stability, and material usage. In order to identify the best option, this study examines several support arrangements for cylindrical pieces [4–7].

METHODOLOGY

In this study, a cylindrical model was selected to evaluate the performance of different support structures. The dimensions of the model were 220 mm in diameter, 80 mm in height, and 10 mm in wall thickness which is shown on figure 1. To ensure stable manufacture, support structures with a support height of 7 mm were only placed to the bottom portion of the cylinder, where the item was joined to the build plate.For every case, the same process settings were applied: 370 W laser power, 0.06 mm layer thickness, 0.1 mm laser beam diameter, 0.07 mm hatch distance, and 1200 mm/s scanning speed. To ensure that the comparison relied solely on the type of support, these factors were held constant. The study directly assessed which design was better at minimizing distortion and enhancing build quality for the cylindrical geometry because all supports had the same overall volume. The shell thickness, voxel mesh size, level of coursing, and critical surface angle were all set to 0.3 mm, 2.5 mm, and 45° for each support case. The support volumes were 1058 mm^3 for contour support, 2053 mm^3 for block support, and 2053 mm^3 for block line support.

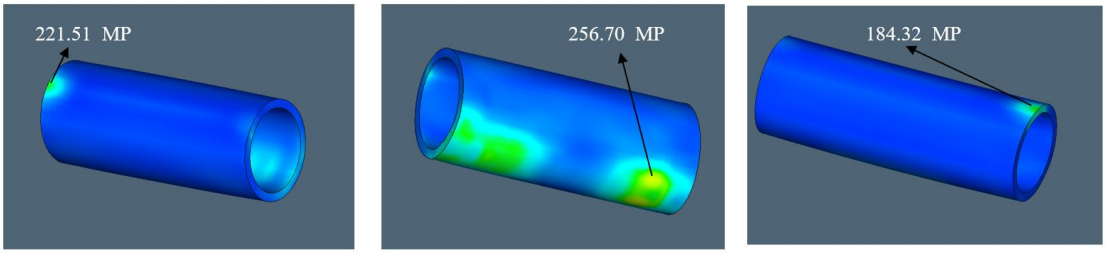


block support line support contour support

Figure 1.It shows max displacements of block, line and contour support

RESULTS AND DISCUSSION

The findings demonstrate that the cylindrical model performed better with block support. It yielded the highest in-tolerance value (81%), the lowest total displacement (0.74 mm), and the lowest surface deviation (0.34 mm). With 0.75 mm displacement, 0.38 mm surface deviation, and 78.7% tolerance that is shown on figure 1, line support demonstrated comparable outcomes but was marginally less successful. With the greatest displacement (0.86 mm), the largest surface variation (0.56 mm), and only 56% tolerance, contour support, on the other hand, performed the worst. Consequently, the best configuration for this geometry was block support.



block support line support contour support

Figure 2. It shows max equivalent stresses of block, line and contour support

CONCLUSION

The best support configuration for the thin-walled cylindrical model in the SLM process, according to this study, is block support. When compared to line and contour supports, it offered the lowest displacement, the lowest surface variation, and the maximum tolerance compliance. Block support is therefore advised for enhancing structural stability and dimensional correctness in cylindrical shapes.

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