OPTIMIZATION OF A SHAPE AND STRUCTURE OF AN INFILL IN 3D PRINTED WHEELS

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The study presents the development and optimization [1, 2] of a wheel structure designed for additive manufacturing using lattice infill structures. The wheel has a width of 120 mm and consists of two cylindrical rings forming a space filled with lattice structures. Eight types of cubic-based infill geometries were analyzed: BCC, Diamond, BCC–FCC, Dode, Crown, FCC, Cube, and Honeycomb [3].

The model was developed in the CATIA 3DEXPERIENCE environment using parametric and lattice design tools. The infill structures were arranged radially from the center of the wheel to ensure uniform distribution. Each structure was defined using parameters such as cell size, bar radius, neutral radius, and minimum bar length. The aim of the optimization process was to obtain the lightest possible structure while maintaining low displacement and stress values.

To evaluate the mechanical performance of the designs, a static strength test was performed. A bearing load of 250 N was applied to the inner cylindrical surface, representing the load acting on one wheel of a six-wheel transport platform carrying up to 100 kg. The simulation also included gravitational forces and contact with the ground. Because the optimization involved multiple criteria like mass, maximum displacement, and maximum stress, a multi-criteria decision approach based on the Pareto front was applied. After analyzing dominance relations between solutions, the remaining variants were evaluated using the distance from an ideal point representing the best values of each criterion. To ensure a fair comparison between parameters with different units and magnitudes, the results were normalized using the min - max method.

The ranking obtained after normalization indicated that the BCC, FCC, and BCC-FCC lattice structures are closest to the ideal solution. The BCC structure provides the best compromise between low mass and high stiffness, while the FCC and BCC-FCC variants also show favorable mechanical performance.

References

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