Design of lightest pyramidal lattice hollow truss structures with maximum sound insulation performance under random and interval uncertainties

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Abstract

Periodic lattice structures can own high effective stiffness or intensity to density ratios. This makes them well suited for lightweight structural applications, such as aircraft. Noises are always undesirable for the passengers on the aircraft. In this work, we investigate the sound insulation characteristic of the pyramidal lattice structures with hollow trusses by using finite element analysis method. To design a structure with least weight and maximum sound insulation performance, a multiobjective robust optimization with random and interval uncertainties is developed by considering probabilistic and/or bounded nature of uncertainties. The design of experiment method and the Kriging response method are used as a bridge for connecting the complex implicit design problem and the mathematical optimization method. A nesting optimization is involved in the design problem. The structural response is obtained in the inner loop using Monte Carlo simulation, and the robust Pareto solution is achieved by implementing the Genetic Algorithm. The pyramidal lattice hollow truss structure and the multiobjective robust optimization method reported can guidance the aircraft's lightweight and noise reduction design.

Keywords: pyramidal lattice structures; lightweight; sound insulation; multiobjective robust optimization; random and interval uncertainties.

Reference

[1] Chen, T.T., Liu, J., Tan, D.G., and Wen, G.L. (2017) Research on sound transmission performance in pyramidal lattice truss structures with hollow trusses, Zhendong yu Chongji/Journal of Vibration and Shock. (In publishing)