

PROCEEDINGS

Topology Optimization of SMA Lattice Structures Under Static, Harmonic, and Shock Loadings

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ABSTRACT

Shape memory alloy (SMA) lattice structures are promising for aerospace vibration and shock mitigation because of their low effective stiffness, recoverable large deformation, and superelastic energy dissipation capability [1–4]. For lightweight equipment subjected to complex service environments, it is necessary to develop a unified design framework that can simultaneously consider static load-bearing requirements and dynamic performance under harmonic and shock loadings [5–9].

In this study, a topology optimization framework for SMA lattice structures under static, harmonic, and shock loadings is developed [10]. Static analysis is introduced to ensure the basic load-bearing capacity of the structure, harmonic response analysis is employed to evaluate high-frequency vibration isolation performance, and shock response analysis is used to characterize transient dynamic mitigation capability. Based on these analyses, the structural topology is optimized to reduce dynamic response while maintaining acceptable static stiffness. The numerical results show that the proposed method can effectively suppress resonance response and reduce shock-induced dynamic amplification, while preserving the essential load-bearing function of the structure. The present work provides a feasible approach for the integrated design of SMA lattice structures in aerospace applications involving high-frequency vibration and shock environments.

KEYWORDS

Shape memory alloy lattice structures; topology optimization; harmonic loading; shock loading; vibration isolation

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