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OPTIMIZED DESIGN OF LATTICE CORES WITH IMPROVED BUCKLING STRENGTH FOR ADDITIVE MANUFACTURING

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Abstract: Sandwich structures with lattice cores are lightweight yet exhibit high specific stiffness, strength and energy absorption abilities. Traditional design of lattice cores are composed of straight and uniform truss members. However, the advances of additive manufacture free the design space and allow to design lattice cores with complex truss profiles for improved mechanical performance. In this paper, a shape design method is proposed for lattice truss members to improve their buckling loads, which dominate the compressive strength for low density lattice structures. Five types of lattice cores are studied, including three simple lattices (Kagome, bcc and fcc) and two hybrid lattices (bccz and fbcc). For the simple lattices whose trusses are considered identical, the proposed method is able to optimize the cross-sectional variations, while the truss diameters as well as cross-sectional variations of each type of truss are optimized for hybrid lattice cores. The sandwich plates with optimized lattice cores are fabricated via additive manufacturing and tested under compression loads. Experimental results show that the buckling strength of the optimized bccz and fcc lattice cores are improved by 91% and 22% compared to their original uniform counterparts of the same weight; meanwhile their stiffness is improved as well. Kagome and bccz lattice cores perform the superior specific stiffness and compressive strength among the five lattice configurations studied, showing their potentials for aerospace and automotive applications.