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Bin Han[1,2*], Ke-ke Qin[2,3], Qian-cheng Zhang[2,3], Qi Zhang[1], Tian Jian Lu[2,3*], Bing-Heng Lu[1]

[1] *School of Mechanical Engineering, Xi'an Jiaotong University, Xi'an 710049, PR China*

[2] *MOE Key Laboratory for Multifunctional Materials and Structures*

Xi'an Jiaotong University, Xi'an 710049, China

[3] *State Key Laboratory for Mechanical Structure Strength and Vibration*

Xi'an Jiaotong University, Xi'an 710049, China

Abstract The free vibration and buckling behaviors of foam-filled composite corrugated sandwich plates under thermal loading are investigated theoretically. A refined shear deformation theory is extended incorporating two different combinations of hyperbolic and parabolic shear shape functions. Equivalent thermoelastic properties of the foam-filled corrugation are obtained using the method of homogenization based on the Gibbs free energy. Based on hyperbolic-polynomial variation of all displacements across the thickness of both face sheets and sandwich core, the shear plate theory accounts for both transverse shear and thickness stretching effects. The theoretical predictions are validated against existing results as well as finite element simulations. The effects of geometric and material parameters on natural frequency and critical temperature change for buckling are systematically investigated. The proposed theory is not only accurate but also simple in predicting the free vibration and thermal buckling responses of composite sandwich plates with foam-filled corrugated cores.

Keywords Composite sandwich plate; Foam-filled corrugated core; Refined shear theory; Thermal loading

1. Introduction

Sandwich plates with periodic lattice cores such as pyramidal trusses and square honeycombs possess superior bending stiffness, strength and shock resistance with respect to monolithic plates of the same mass, and present opportunities for additional functionality, such as vibration control, thermal transport and energy absorption [1,2]. As one type of lattice topologies, two-dimensional (2D) corrugated panels as sandwich core have enjoyed widespread applications in areas of packaging, building and transportation industry (e.g., skin frame of high-speed train, naval craft and rocket engine shell), which is attributed mainly to their relatively low cost, ease of fabrication and reparability, flexibility in design, and good structural performance [3]. However, under compressive loading, a corrugated sandwich core first deforms by stretching of its struts (core webs) and then collapses by Euler or plastic buckling at a small strain, softening rapidly due to node failure and/or core buckling. Metallic corrugations are thus less attractive for energy absorption applications as large forces are transferred but limited amount of energy is absorbed [4]. Moreover, the transverse shear and bending resistance of corrugated sandwiches are

[*] Corresponding author. Tel.: +86 29 82665600; Fax: +86 29 83234781.
E-mail address: hanbinghost@mail.xjtu.edu.cn (B. Han), tjlu@mail.xjtu.edu.cn (T.J. Lu).