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ORIGINAL PAPER

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Combined effect of temperature dependent material properties and boundary conditions on non-linear thermal stability of porous FG beams

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Abstract This paper presents an analytical formulation to investigate functionally graded porous beams' nonlinear thermal buckling performance under various boundary conditions. The current model incorporates innovative cinematic techniques with the focus on the stretching effect and the iteration techniques. The material properties of the porous FG beams are temperature-dependent and vary according to a simple power-law distribution. The validity of the present theory' results is confirmed by comparing them with those obtained by other researchers. The findings demonstrate that the critical buckling temperature in TD and TID ranges from 1.03 to 1.27% for a uniform distribution and 1 to 1.47% for linear and non-linear distributions. Conversely, for regular porosity variation, the critical buckling temperatures fluctuate between 0.99 and 1.74%, and between 0.99 and 1.59% for porosity variation. Furthermore, the influence of boundary conditions becomes more pronounced when the nonlinear temperature difference is high.

1 Introduction

Several studies have comprehensively investigated the combined effect of temperature-dependent material properties and boundary conditions on the nonlinear thermal stability of porous functionally graded (FG) beams. The beams' material properties are expected to fluctuate continuously in the thickness direction according to a power-law index. The effect of power-law index, porosity volume fraction, and slenderness ratio on the thermal buckling behavior of FG beams has been thoroughly analyzed [1, 2]. It has been convincingly demonstrated that the distribution of material properties, including porosity, significantly affects the thermal stability response of the beams [3–5]. Additionally, boundary conditions, such as thermal insulation or adiabatic conditions, have been found to influence the beams' thermal buckling and post-buckling responses to a considerable extent. The temperature-dependent nature of material properties has also been established to play an essential role in the thermal stability behavior of FG structures.

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