

Accepted Manuscript

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PII: S1359-8368(17)31984-4

DOI: [10.1016/j.compositesb.2017.10.022](https://doi.org/10.1016/j.compositesb.2017.10.022)

Reference: JCOMB 5342

To appear in: *Composites Part B*

Received Date: 12 June 2017

Revised Date: 23 August 2017

Accepted Date: 10 October 2017

Please cite this article as: Fazzolari FA, Generalized exponential, polynomial and trigonometric theories for vibration and stability analysis of porous FG sandwich beams resting on elastic foundations, *Composites Part B* (2017), doi: 10.1016/j.compositesb.2017.10.022.

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Generalized Exponential, Polynomial and Trigonometric Theories for Vibration and Stability Analysis of Porous FG Sandwich Beams Resting on Elastic Foundations

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Abstract

The present article investigates the free vibration and elastic stability behaviour of three-dimensional functionally graded sandwich beams featured by two different types of porosity, with arbitrary boundary conditions and resting on Winkler-Pasternak elastic foundations. The investigation is carried out by using the method of series expansion of displacement components. Various hierarchical refined exponential, polynomial, and trigonometric higher-order beam theories are developed in a generalized manner and are validated and assessed against 3D FEM results. The weak-form of the governing equations (GEs) is derived via Hamilton's Principle. The GEs are then solved by using the Ritz method, whose accuracy is significantly enhanced by orthogonalizing the algebraic Ritz functions by virtue of the Gram-Schmidt process. Convergence and accuracy are comprehensively analysed by testing 86 quasi-3D beam theories. Moreover, the effect of significant parameters such as slenderness ratio, volume fraction index, porosity coefficient, elastic foundation coefficients, FG sandwich beam typology as well as boundary conditions, on the circular frequency parameters and critical buckling loads, is discussed.

Keywords: Quasi-3D beam theories, Free Vibration, Stability, FG sandwich beams, Porosities, Elastic foundations, Ritz method.

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