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Flexural-torsional vibration and buckling of thin-walled bi-directional functionally graded beams

Tan-Tien Nguyen[1], Jaehong Lee[2,*]

Department of Architectural Engineering, Sejong University
209 Neungdong-ro, Gwangjin-gu, Seoul 05006, Republic of Korea

Abstract

The paper introduces an analysis of flexural-torsional vibration and buckling of thin-walled bi-directional FG beams. Several cross sections have been conducted such as mono-symmetric I-shaped and channel sections in which material properties are assumed to vary across blade thickness and along axial direction. Governing equations and finite element model are developed. The model is capable of capturing all complex eigenvalue problems, also provides a highly accurate prediction of vibrational shapes and buckling capacity. Since the material changes, the obtained results reflect the relative relation between the behaviors of the beam and the transformation of internal properties, for example, Young's modulus, density, etc. Effects of gradient parameters on the vibrational frequencies or limit loads of a thin-walled bi-directional FG beam under various configurations and boundary conditions have also been parametrically studied.

Keywords: A. Hybrid; B. Vibration; B. Buckling; C. Computational modeling.

1. Introduction

As developed by mixing two or more distinct materials, Functionally Graded Materials (FGMs) were deemed as one of a new class of advanced composites in favor of the superiority in thermal and flexural resistances which is rooted in the fact that these advantages have been generally attributed to the inherent cutting-edge metal or ceramic. Recent years have seen the introduction of a variety of researches [1–4]. In turn, understanding its behaviors enables researchers and 3D functional printers to reach better techniques for simulation, design and fabrication [5, 6].

Undeniably, in the past few decades, FGMs have been singled out for special structures because of spatially continuous and flexible variation of volume-fraction gradation through-the-thickness or axial direction comparing to discontinuity in classical laminated composites [7, 8]. Several outstanding researches are highlighted. Arciniega et al. [9] introduced an

*Corresponding author.
[1]E-mail: *tien.ntan@gmail.com*
[2]E-mail: *jhlee@sejong.ac.kr*