Accepted Manuscript

Contribution rates of normal and shear strain energies to the natural frequencies of functionally graded shear deformation beams

Jung Woo Lee, Jung Youn Lee

PII: S1359-8368(18)32298-4

DOI: 10.1016/j.compositesb.2018.09.050

Reference: JCOMB 6020

To appear in: *Composites Part B*

Received Date: 25 July 2018

Revised Date: 28 August 2018

Accepted Date: 21 September 2018

Please cite this article as: Lee JW, Lee JY, Contribution rates of normal and shear strain energies to the natural frequencies of functionally graded shear deformation beams, *Composites Part B* (2018), doi: https://doi.org/10.1016/j.compositesb.2018.09.050.

Contribution rates of normal and shear strain energies to the natural frequencies of functionally graded shear deformation beams

Jung Woo Lee [a] and Jung Youn Lee [b,]*

[a] *Technology Research & Development Institute, KEPCO KPS,211, Munhwa-ro,Naju-si, Jeollanam-do, 58217, Republic of Korea*
[b] *Department of Mechanical System Engineering, Kyonggi University, 154-42, Gwanggyosan-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16227, Republic of Korea*
**Corresponding Author. Tel.: +82-31-249-9811, Fax: +82-31-244-6300, e-mail address: jylee@kgu.ac.kr.*

Abstract

Based on the first-order shear deformation theory, this study investigated the effect of shear deformation on the contribution rates of normal and shear strain energies to the natural frequencies of functionally graded beams. This is a new analytical method to investigate the effect of shear deformation, and the analytical technique can more accurately evaluate the effect of shear deformation compared with those using the frequency ratio. The coupled axial-bending vibrations are considered, and the material properties of the structure are continuously varied according to power law distribution along the height of the cross section. Under these assumptions, the contribution rates of the related strain energies are predicted from the relationship between the maximum strain and kinetic energies. The shape function of the displacement required in the computation of the contribution rate is deduced by an exact transfer matrix method, and the developed method is used to obtain the exact eigenpairs and shape functions. The effect of shear deformation is examined for various boundary conditions, length-to-height ratios, and variations in the power law index. Therefore, the length-to-height ratios capable of ignoring these shear effects are analyzed for the first four bending-dominated frequencies of the functionally graded beams. The accuracy of the developed transfer matrix method is demonstrated via comparison with the results discussed in previous works; further, we successfully calculated the contribution rate. In addition, the axial-bending displacements coupled by the use of functionally graded materials are investigated to ascertain the reason for the decoupling phenomenon in homogeneous beams.

Keywords: functionally graded beam, FSDBT, contribution rate, strain energy, transfer matrix method.