Accepted Manuscript

Size dependent bending analysis of two directional functionally graded microbeams via a quasi-3D theory and finite element method

Armağan Karamanlı, Thuc P. Vo

PII: S1359-8368(17)34214-2

DOI: 10.1016/j.compositesb.2018.02.030

Reference: JCOMB 5555

To appear in: *Composites Part B*

Received Date: 5 December 2017

Revised Date: 6 February 2018

Accepted Date: 27 February 2018

Size dependent bending analysis of two directional functionally graded microbeams via a quasi-3D theory and finite element method

Armağan Karamanlı[1,‡] , Thuc P. Vo[2,3]

[1] Department of Mechatronics, Faculty of Engineering and Architecture, Istanbul Gelişim University, 34215,Istanbul, Turkey.

[2] Department of Mechanical and Construction Engineering, Northumbria University, Ellison Place, Newcastle upon Tyne NE1 8ST, UK

[3]Institute of Research and Development, Duy Tan University, 03 Quang Trung, Da Nang, Viet Nam

‡ Corresponding Author; Armağan Karamanlı, Istanbul Gelişim University, 34215, Istanbul, Turkey, Tel: +90 212 422 7020, armagan_k@yahoo.com

Abstract

This paper presents the flexural behaviour of two directional functionally graded (2D-FG) microbeams subjected to uniformly distributed load with various boundary conditions. A four-unknown shear and normal deformation theory or quasi-3D one is employed based on the modified couple stress theory, Ritz method and finite element formulation. The material properties are assumed to vary through the thickness and longitudinal axis and follow the power-law distribution. Firstly, the static deformations of conventional FG microbeams are investigated to verify the developed finite element code. For the convergence studies, a simply supported FG microbeam is considered by employing various number of elements in the problem domain, aspect ratios, material length scale parameters and gradient indexes. The verification of the developed code is established and then extensive studies are performed for various boundary conditions. Secondly, since there is no reported data regarding to the analysis of 2D-FG microbeams, verification studies are performed for 2D-FG beams with different aspect ratios and gradient indexes. The effects of the normal and shear deformations as well as and material length scale parameters on the flexural behaviour of the 2D-FG microbeams are investigated. Finally, some new results for deflections of conventional FG and 2D-FG microbeams for various boundary conditions are introduced for the first time and can be used as reference for future studies.

Keywords: 2D Functionally Graded Microbeam, Finite Element Method, Quasi-3D Theory, Modified Couple Stress Theory.