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Size-dependent vibration of bi-directional functionally graded microbeams with arbitrary boundary conditions

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Abstract

In this paper, the free vibration behaviour of bi-dimensional functionally graded (BDFG) microbeams under arbitrary boundary conditions (BCs) is studied. Based on the frame work of the modified couple stress theory and Hamilton's principle, governing equations of motion are developed for the BDFG microbeams using a quasi-3D theory. The formula then can be reduced to a higher-order beam theory (HOBT) of conventional functionally graded (FG) microbeams with the material properties varying along the thickness direction only. Two types of BDFG microbeams with different patterns of material volume distribution are considered. The material properties used in this study are assumed to vary exponentially along both longitudinal and thickness directions of microbeams. Based on the state-space concept, the governing equations are solved for natural frequencies and vibration mode shapes of microbeams under various BCs. The effects of material distribution, geometric parameters and BCs are also investigated to examine the size-dependent behaviour of BDFG microbeams.

Keywords: Bi-directional functionally graded microbeam; state-space based solution; modified couple stress theory; quasi-3D theory.

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