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A Refined Quasi-3D Isogeometric Analysis for Functionally Graded Microplates based on the Modified Couple Stress Theory

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Abstract

The isogeometric analysis associated with a novel quasi-3D shear deformation theory is proposed to investigate size-dependent behaviours of functionally graded microplates. The modified couple stress theory with only one material length scale parameter is employed to effectively capture the size-dependent effects within the microplates. Meanwhile, the quasi-3D theory which is constructed from a novel seventh-order shear deformation refined plate theory with four unknowns is able to consider both shear deformations and thickness stretching effect without requiring shear correction factors. The NURBS-based isogeometric analysis is integrated to exactly describe the geometry and approximately calculate the unknown fields with higher-order derivative and continuity requirements. The proposed approach is successfully applied to study the static bending, free vibration and buckling responses of rectangular and circular functionally graded microplates with various types of boundary conditions in which some benchmark numerical examples are presented. A number of investigations are also conducted to illustrate the effects of the material length scale, material index, and aspect ratios on the responses of the microplates.

Keywords: Isogeometric analysis, Functionally graded microplates, Modified couple stress theory, Refined plate theory, Quasi-3D theory.

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