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Three-dimensional buckling and free vibration analyses of initially stressed functionally graded graphene reinforced composite cylindrical shell

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Abstract

The buckling and free vibration of initially stressed functionally graded cylindrical shell reinforced with non-uniformly distributed graphene platelets (GPLs) are investigated using the state-space formulation based on three-dimensional elasticity theory. The shell is under an axial initial stress and composed of multilayers with GPLs uniformly dispersed in each individual layer but its weight fraction changing layer-by-layer along the thickness direction. The modified Halpin-Tsai model and rule of mixtures are employed to evaluate the effective elastic properties of the GPL-reinforced shell. Analytical buckling and frequency solutions are obtained for simply supported shells. Numerical results are presented for functionally graded GPL-reinforced cylindrical shells with five GPL dispersion patterns (GPL-UD, GPL-V, GPL-A, GPL-X, and GPL-O). The effects of GPL weight fraction, dispersion pattern, geometry, and size as well as the influence of initial stress on the buckling and free vibration characteristics of the shell are discussed in detail. It is found that the addition of a small amount of GPLs significantly increases the critical buckling stress and natural frequencies. The GPL-X pattern outperforms other patterns for thin composite shells while the uniform pattern GPL-UD works better for thick composite shells.

Keywords: buckling; vibration; functionally graded plate; graphene platelet; three-dimensional elasticity theory; state-space approach.

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