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# Aeroelastic Analysis of Functionally Graded Rotating Blades Reinforced with Graphene Nanoplatelets in Supersonic Flow

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**Abstract**

In this study, the aeroelastic analysis of functionally graded (FG) multilayer graphene platelet reinforced polymer composite (GPLRPC) rotating blades under supersonic flow is investigated. It is considered that the graphene platelet (GPL) nanofillers are distributed in the matrix either uniformly or non-uniformly along the thickness direction. Four GPL distribution patterns namely, U-GPLRPC, Λ-GPLRPC, X-GPLRPC and O-GPLRPC are considered. The effective material properties of GPLRPC layers are obtained via the modified Halpin-Tsai micromechanics model and the rule of mixture. Based on the first-order shear deformation theory, the dynamic equations of thin-walled blades reinforced with GPL are obtained using extended Hamilton's principle. The aerodynamic pressure is assumed in accordance with the quasi-steady supersonic piston theory. The extended Galerkin method (EGM) is employed to transform the coupled equations of motion to a general eigenvalue problem. The influences of rotating speed, GPL distribution, GPL weight fraction, geometry of GPL nanofillers, geometric parameters and Mach number on the natural frequencies of the system are studied. The results indicate that the Λ-GPLRPC distribution pattern predicts the highest natural frequencies for the composite blade. Also, the natural frequencies of the composite blade significantly increase by adding a small amount of GPL to the polymer matrix.

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