Finite Element Modal Analysis for Composite and Stiffened Beam Structures with Geometric Non-Linearities

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ABSTRACT

Predicting the vibrations of wing-box structures is a crucial aspect of the aeronautic design to avoid aeroelastic effects during normal flight operations. The deformed configuration of a wing structure during flight can induce non-linear couplings which results in a different dynamic behavior from the linear counterpart, for this reason, it is necessary to include non-linear loaded configurations to perform more realistic simulations. Moreover, with the advent of composite materials and aeroelastic tailoring, new simulation tools are needed to include the coupling effects caused by these materials and technologies. In this research, a beam finite element with bending-torsion coupling formulation has been used to investigate the effects of the self-weight of beam structures with different aspect ratios. The nonlinear effects induced by the load have been included in the finite element formulation with Hamilton's Principle and a linearization approach and performing modal analysis on an equilibrium configuration. The results obtained with the beam finite element model have been compared with numerical and experimental evidence.

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