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**AEROELASTIC BEHAVIOR STUDY OF FINITE WINGS
USING 3-D UNSTEADY AERODYNAMIC MODEL**

By

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ABSTRACT

A numerical model for simulating the structural/aerodynamic coupling for finite wings was developed. The model simulates unsteady 3-D flow and it is general and not restricted by planform, angle of attack, aspect ratio ... etc. Flutter and dynamic responses to changes in aerodynamic and geometrical parameters have been studied in this work. The aerodynamic loads are calculated by using the unsteady vortex-lattice method which considers the wake and its effect on the loads. The wing is represented as a cantilever beam constrained to flexural and torsional motions. The equations of motion for the beam are derived using Newton's law while assuming small deflections. These deflections are represented as an expansion in terms of a limited number of free-vibration modes and generalized coordinates. A predictor-corrector scheme is used to integrate the equations of motion. The aerodynamic and structural models are solved simultaneously and interactively through an iterative scheme in the time domain. The simulation handles both static and dynamic solutions for the aeroelastic model. Parameters that may affect the dynamic response were studied. The wing stability under flutter conditions showed great sensitivity to these parameters. The wing speed appears to be the most important aerodynamic parameter for flutter onset. Below the flutter speed, the oscillations die out with time and the wing returns to its static equilibrium position. At the flutter speed, the oscillations are sustained and the bending and torsional deflections have the same frequency. Above the flutter speed, oscillations grow quite fast unless the motion is suppressed. The effect of the angle of attack on the wing stability is small since the model assumes no flow separation on the wing surface. When the elastic axis is coincided with the inertial axis, the study showed that the location of these axes has a strong effect on the dynamic response. The wing aspect ratio had also been shown to have strong effect on the oscillation amplitudes and the wing stability.