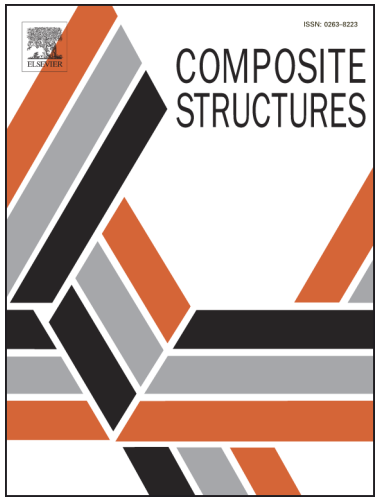

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Aerothermoelastic analysis and active flutter control of supersonic composite laminated cylindrical shells

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Abstract

The aerothermoelastic characteristics of the supersonic laminated cylindrical shell are analyzed, and the active flutter control of the aeroelastic structure is also investigated using the piezoelectric material. In the structural modeling, the influences of the in-plane thermal load on the transverse deformation are taken into account. The aerodynamic pressure is evaluated using the supersonic piston theory. Hamilton's principle and the Galerkin's method are used to establish the equation of motion. The proportional feedback and LQG control methods are applied to design the controller. The aerothermoelastic analysis for the laminated cylindrical shell is carried out using the frequency- and time-domain methods. The influences of the ply angle on the flutter and thermal buckling properties are investigated. The active flutter control effects of different controllers are compared. Numerical simulation shows that the LQG controller is more accurate and effective than the LQR and proportional feedback controllers.

Keywords: supersonic; laminated cylindrical shell; flutter; thermal buckling; LQG

1 Introduction

Aeroelasticity is a subject which studies the coupling effect of aerodynamic force, elastic force as well as the inertial force. Aeroelastic problems occur in the aircraft structures frequently. So there are a large number of literatures having studied the aeroelastic characteristics of structures [1-10]. Panel flutter is one of the aeroelastic problems. It is the oscillation of the external skin of a flight vehicle when exposed to airflow along its surface. Many literatures have conducted the investigations on the panel flutter.

Bismarck-Nasr [11] studied the supersonic flutter of circular cylindrical shells subjected to internal pressure and axial compression using the finite element method. Amabili and Pellicano [12] conducted the investigations on the aeroelastic stability of nonlinear circular cylindrical shells in supersonic flow. The effect of viscous structural damping was considered. Librescu and Marzocca [13]

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