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Damping Influences on Instability Characteristics of Panel Aero-Thermo-Elastic System

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ABSTRACT

The complex damping influences on the instability characteristics of the panel aero-thermo-elastic system are theoretically investigated from the energy perspectives. Firstly, by assuming a constant, uniform thermal loading and adopting the piston theory, the panel aeroelastic governing equation is obtained. After deriving the panel buckling and vibration modes, the reduced order model can be built and adopted to investigate the system primary instability in the modal coordinates. Then, introducing the modal damping coefficients ratio $\eta > 0$, the critical parameters of the panel flutter oscillation are theoretically evaluated based on the on-conservative energy balance principle, thus the system instability characteristics can be investigated. The results show that the system oscillatory and static buckling instability characteristics are significantly regulated by the thermal loading and modal damping. For the oscillatory instability, there exists the damping paradox, which is associated with the system energy dissipation efficiency, and can be quantitatively evaluated by the ratio $2\sqrt{\eta}/(1+\eta)$. The system static buckling instability characteristics is also affected by the modal damping, and this damping destabilization is clarified based on Hamiltonian energy conservation law. The results agree well with that obtained by Routh-Hurwitz criteria.

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