Hopf Bifurcation on Heated Curved Panel Flutter in Supersonic Air Flow

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Abstract

Heated curved panels flutter in supersonic air flow will affect fatigue life and flight performance of aircrafts, thus the research on heated curved panels flutter was an important problem in flight design. A nonlinear aero-elastic partial differential equation for two-dimensional heated curved panels in supersonic flow was established based on the von-Karman nonlinear strain-displacement relation and aerodynamic force model of supersonic flow, which was described by improved piston theory. The aero-elastic partial differential equation was derived to a four-dimensional ordinary differential equation system by using second order Galerkin discretization method. The algebraic criterion of the Hopf bifurcation was utilized in the equation system to derive the Hopf bifurcation point of the system (also the flutter critical value).Therefore, analytical expressions of flutter critical dynamic pressure and vibration frequency were theoretically derived. Then, a numerical experiment was established, and the agreement of numerical result and theoretical value was validated. The result showed that flutter dynamic pressure decreased and then increased with initial curvature rising. For small curvature panel, flutter dynamic pressure also first decreased and then increased with temperature rising, while for large curvature panel flutter dynamic pressure always increased with temperature rising. The established equation system and analytical expression of Hopf bifurcation point can provide some guidance for heated curved panel in supersonic air flow.

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