

PROCEEDINGS

Analysis of Aeroacousticelastic Response for Cavity-Plate System Undergoing Supersonic Flow

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ABSTRACT

Cavity closed with a thin plate is a common structure in aircrafts, such as landing gear compartments and skin skeletons. The plate undergoing aerodynamic pressure on top is generally vibrating in the amplitude of thickness, which will induce an acoustic pressure in the cavity underneath and it will further affect the panel response. Considering both aerodynamic and acoustic pressure on the panel, there will be an interest to investigate the aero-acoustic-structure coupling mechanism and the aeroacoustoelastic response of the plate. Von Karman plate theory, piston theory and two-dimensional partial differential acoustic equation are employed for panel geometry nonlinearity, aerodynamics and cavity pressure, respectively. The resultant aeroacoustoelastic equations are transformed into Ordinary Differential Equations (ODEs) via the Galerkin method, which are solved with fourth-order Runge Kutta numerical integration. The numerical results find that: 1) compared to panel ignoring the cavity pressure, the critical dynamic pressure for the Limit Cycle Oscillations (LCOs) decreases obviously with the cavity pressure; 2) in terms of the stability regions in the parameter plane of the external in-plane pressure and the dynamic pressure, the static stable region disappears and is replaced by the dynamic stable region, i.e. buckling; and the regions of buckling and LCOs are both increased; 3) the ratio of depth to length of cavity (H/L) is evaluated, and the results show that the smaller the H/L is, the LCO occurs earlier with larger deflection; 4) specially, as H/L is increasing to 2.3, the critical dynamic pressure for LCO is consistent with the value without the cavity pressure, and this is still applicable for H/L larger than 2.3. This finding is interesting and important for engineering application. Another way said, the impact of cavity pressure induced from panel vibration can be ignored for H/L larger than 2.3, on the contrary, we have to pay attention to the acoustic pressure on the fluttering panel.

KEYWORDS

Cavity-plate system; aeroacousticelastic; panel flutter

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