Zeroth-order flutter prediction for cantilevered plates in supersonic flow

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ABSTRACT:

An aeroelastic prediction framework in MATLAB with modularity in the quasi-steady aerodynamic methodology is developed. Local piston theory (LPT) is integrated with quasi-steady methods including shock-expansion theory and the Supersonic Hypersonic Arbitrary Body Program (SHABP) as a computationally inexpensive aerodynamic solver. Structural analysis is performed using bilinear Mindlin–Reissner quadrilateral plate elements. Strong coupling of the full-order system and linearization of the modal-order system are implemented. The methodology is validated against published experimental data in the literature and benchmarked against Euler computation in the Edge CFD code. The flutter dynamic pressure is predicted to be within 10% of the experimental value for 140 times lower computational cost compared to CFD. Good agreement in other cases is obtained with the industry-standard ZONA7 and ZONA7U codes.

Keywords

Zeroth-order; Flutter; Local piston theory; Shock-expansion; Cantilevered plate