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Aeroelastic prediction methods in supersonic flows for missile design

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Abstract

The prediction of aeroelastic instabilities such as flutter is important in the multi-disciplinary design and preliminary testing of missiles. Flutter prediction software varies in the fidelity of analysis, with accurate solutions being computationally expensive and involving the use of CFD.

In this dissertation, a review is given of approximate methods for supersonic aeroelastic analysis. A general formulation of piston theory is developed to encompass both classical and local piston theory, and the literature on piston theory and its application in aeroelastic analysis is reviewed.

An aeroelastic prediction method is developed for cantilevered trapezoidal plates in supersonic flows based on shock-expansion theory and local piston theory. The method is validated against 3D unsteady Euler aeroelastic computations in the Edge CFD solver and against experimental flutter data in literature.

The prediction method is shown to be suitable for computationally inexpensive aeroelastic parametric studies applicable to missile fin design.