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Effect of spanwise flexibility on aerodynamics of a plunging wing[1]

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— The effect of spanwise flexibility on the aerodynamic performance of a plunging wing is investigated numerically. To solve the fluid-structure interaction problem, a computational aeroelasticity framework has been developed based on an implicit coupling procedure between a pressure-based Navier-Stokes finite volume solver and a quasi-3D finite element solver capable of handling geometrically nonlinear composite beam-like and plate-like dynamic deformations. Three different variations in the spanwise flexibility of a NACA0012 cross-sectional rectangular wing of aspect ratio 3 are considered at chord Reynolds number of $3x10^4$, reduced frequency (based on semi-chord) of 1.82, for prescribed pure plunge actuation at the leading edge. The computed results in terms of time histories of thrust coefficient, wing shape deformation, and flow structures are compared to experimental data. Spanwise flexibility of the plunging wing affects the amplitude and phase lag of the wing tip displacement, and hence the instantaneous angle-of-attack and associated flow structures. Together, they can substantially modify the aerodynamic force.

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