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Understanding and Toward Controlling the Hydroelastic Response and Stability of Hydrofoils in Cavitating Flows[1] DENIZ TOLGA AKCABAY, YIN LU YOUNG, University of Michigan — This study examines the hydroelastic behavior of hydrofoils in cavitating flows. The hydrofoil was modeled as a 2-D structure which can undergo spanwise bending and twisting deformations and the flow is modeled through the unsteady RANS equations. The results show that: 1) amplitude of the dynamic load fluctuations on the hydrofoil can exceed their mean values as the highest load fluctuations and vibrations occur when maximum cavity length is close to foil trailing edge, and the fluctuations decrease when in stable supercavitation; 2) lock-in can lead to dynamic load amplifications and focusing of the frequency at the system resonance frequency, and the system resonance frequency varies with cavitation volume due to changes with fluid added mass; 3) viscous effects, in general, tend to delay static divergence, but unsteady cavity/vortex shedding can lead to flutter and lock-in; 4) the mean hydroelastic loads/deformations are bounded by the stall limit and quasi-steady potential flow estimates for the fully wetted and supercavitating regimes; and 5) transient, viscous fluid-structure interaction models are needed to predict the dynamic response and stability of flexible hydrofoils. Finally, results will be shown to illustrate potential strategies that could be used to minimize cavitation and enhance stability.

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