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Influence of Fluid, Solid, and Geometric Parameters on the Fluid-Structure Interaction Response and Stability of Flexible Lifting Surfaces[1]
EUN JUNG CHAE, DENIZ TOLGA AKCABAY, YIN LU YOUNG, University of Michigan — There is an increasing interest to use innovative passive/active flexible lifting surfaces to take advantage of the fluid-structure interaction (FSI) response to improve performance or harvest energy. However, design and testing of flexible lifting surfaces are quite complicated, particularly for lightweight structures in a dense, viscous fluid. The objectives of this work are to (1) investigate the influence of varying fluid, material, and geometric parameters on the FSI response and stability boundaries, and (2) to develop generic parametric maps to facilitate the design of flexible lifting surfaces In particular, the focus is on the influence of solid-to-fluid density ratio, Reynolds number, relative stiffness ratio, and relative excitation frequency ratio on the FSI response and static/dynamic divergence and flutter stability boundaries. The results show that the governing failure mode transitions from flutter to dynamic divergence to static divergence when the solid-to-fluid added mass ratio decreases. In addition, classic linear potential theory is severely under-conservative in predicting the flutter boundary, and cannot predict the transition to dynamic divergence for cases in the low mass ratio regimes due to the strong nonlinear, viscous FSI response that develops when the fluid forces are comparable or greater than the solid forces.

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