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The influence of low-order chord-wise flexibility on the performance of a flapping wing JONATHAN TOOMEY, JEFF D. ELDREDGE, UCLA — The aerodynamic role of flexible fight structures in airborne creatures is still poorly understood. The objective of this study is to distill the basic phenomena of flapping with deformable wings for their use in the efficient design of bio-inspired flight vehicles. The target of the study is a two-dimensional wing with rigid components connected by damped torsion springs. This simplified structure reduces the complexity of the problem, while retaining the leading-order influence of wing flexion. The motion of the leading portion of the wing is prescribed with hovering-type kinematics, while the trailing portions respond passively. Numerical simulations are performed with a viscous vortex particle method with strongly-coupled structural dynamics. The investigation focuses on the influences of several key parameters: spring stiffness (from rigid to very flexible), the location of axis of rotation, and the timing between the rotational and translational components of the kinematics. The effects are quantified via several performance measures, including production of mean and rms lift, the mean consumption of power, and the lift per unit power. Some important correlations are identified between the input parameters and the performance metrics, the passive wing deflection and the wake structure. It is shown that variation in the rotation phase lead are accompanied by topological changes in the wake vortex dynamics.

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