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Vortex Shedding vs. Thrust Production for Free-to-Pivot Flat Plates MICHAEL OL, KENNETH GRANLUND, US AIr Force Research Lab — As an abstraction of flapping-wings, we consider flat plates in rectilinear motion, with the leading edge undergoing periodic oscillation, and the plate left free to pivot about its leading edge, between incidence angle limits of $\pm 45^\circ$. Measurements include thrust production and resistive force, with leading edge and trailing edge vortices visualized by dye injection, conducted in a water tunnel operated here as a towing tank. Imposed acceleration of the plate's leading edge produces a rotational motion followed by a translational phase at constant incidence angle, and a reverse rotation at the semi-stroke extremum. Varying aspect ratio from 3.4 to nominally 2D, neither thrust nor resistive force evince an aspect ratio dependency. Reynolds number does not effect flow development or force production across $5000 < \mathrm{Re} < 25000$. Investigating the conjecture that imposed acceleration stabilizes the leading edge vortex, we find no difference across a range of acceleration profiles. The dominant parameter affecting thrust production is the plate stroke to chord ratio, with values of $\sim$6 and above being most favorable. Further, as a simplification of aeroelastic effects conducted with otherwise rigid plates, we consider a plate sliced spanwise and thus forming two hinged plates. This produces both lower thrust and resistive force than in the single-plate case, resulting in no improvement in hovering figure of merit, which amongst all cases peaks at ~ 0.3.

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