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Modeling of flapping-fin propulsion with Stuart-Landau oscillator equation[1] AREN M. HELLUM[2], PROMODE R. BANDYOPADHYAY, Naval Undersea Warfare Center, Newport, RI — Recently, the lowest order thrust measurements in an abstracted twisting and flapping fin have been modeled using a van der Pol-like oscillator (*JFM* **702,** 298-331). A Stuart-Landau oscillator is used here as a higher order model of the interaction of the low aspect ratio flapping fin with its downstream thrust-producing reverse Karman vortex street. "Quasi-steady" equations for the forces produced on flapping fins or wings by the surrounding fluid assume that the lift and drag coefficients are based on 'a_g(t)', a time-variable angle of attack based on the fin's instantaneous position and velocity. In this work, a wake-modified angle of attack 'a(t)' is used, such that '$a = a_g + a_w$' where 'a_w(t)' is based on the circulation in the wake. This modification of the geometric angle of attack 'a_g' is justified generally by the conservation of circulation within the fin-wake system, and we argue that a Stuart-Landau oscillator represents a good approximation of the circulation within the wake. Results of this modeling are compared with experimental data taken on the abstracted penguin wing planform; a strong quantitative agreement exists between the experimental and modeled systems. We also model the effects of Reynolds number and the dependence of system oscillation lock-in on initial condition.

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