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Scaling in Flexible Flapping Wings[1] CHANG-KWON KANG, University of Michigan, HIKARU AONO[2], Japan Aerospace Exploration Agency, WEI SHYY[3], University of Michigan — The role of flexibility on the aerodynamic performance of a flapping wing is investigated. We consider chordwise, spanwise, and isotropic flexibility. Overall, the aerodynamic force is determined by the Reynolds number, reduced frequency (k), and Strouhal number (St). In particular, at the Reynolds number regime of O(10^3-10^4) and the reduced frequency of O(1), the added mass force, related to the acceleration of the wing, is important. Based on the order of magnitude and energy balance arguments, a relationship between the propulsive force and the maximum relative wing tip deformation parameter is established. The parameter depends on the density ratio, St, k, natural and flapping frequency ratio, and flapping amplitude. It seems that the maximum propulsive force is obtained when flapping near the resonance, whereas the optimal propulsive efficiency is reached when flapping at about half of the natural frequency; both are supported by the reported studies.

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