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Flexibility and inertia of flapping wings in forward flight[1] FANG-BAO TIAN, HAOXIANG LUO, Vanderbilt University, XI-YUN LU, University of Science and Technology of China (USTC) — Insect wings typically deform passively in flight under the combined aerodynamic force and inertia of the wing. To study the effect of the wing flexibility on the aerodynamic performance, a two-dimensional numerical study is employed to simulate the fluid-structure interaction of an elastic plate performing forward flight. The leading edge of the plate is clamped, while the rest of the chord is free to deform, leading to passive pitching and a dynamic camber. The wing stiffness and mass ratio are varied, and their effects on the lift, thrust, and aerodynamic power are investigated. The results shows that the moderate chordwise deformation can improve both lift and thrust performance significantly. The instantaneous passive pitching angle and consequently the forces are largely affected by the mass ratio that determines whether the deformation is caused by the wing inertia or the aerodynamic force. The high mass ratio wings, whose deformation is due to the wing inertia, can produce more thrust than the low mass ratio wing at the same amount of deformation. However, the high thrust is gained at a price of more power requirement.

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