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Role of passive deformation on propulsion through a lumped torsional flexibility model[1] NIPUN ARORA, AMIT GUPTA, Indian Institute of Technology Delhi — Scientists and biologists have been affianced in a deeper examination of insect flight to develop an improved understanding of the role of flexibility on aerodynamic performance. Here, we mimic a flapping wing through a fluid-structure interaction framework based upon a lumped torsional flexibility model. The developed fluid and structural solvers together determine the aerodynamic forces and wing deformation, respectively. An analytical solution to the simplified single-spring structural dynamics equation is established to substantiate simulations. It is revealed that the dynamics of structural deformation is governed by the balance between inertia, stiffness and aerodynamics, where the former two oscillate at the plunging frequency and the latter oscillates at twice the plunging frequency. We demonstrate that an induced phase difference between plunging and passive pitching is responsible for a higher thrust coefficient. This phase difference is also shown to be dependent on aerodynamics to inertia and natural to plunging frequency ratios. For inertia dominated flows, pitching and plunging always remain in phase. As the aerodynamics dominates, a large phase difference is induced which is accountable for a large passive deformation and higher thrust.

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