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Propulsion via flexible flapping in granular media[1] ZHIWEI PENG, YANG DING, Beijing Computational Science Research Center, KYLE PIETRZYK, Santa Clara University, GWYNN ELFRING, University of British Columbia, ON SHUN PAK, Santa Clara University — Biological locomotion in nature is often achieved by the interaction between a flexible body and its surrounding medium. The interaction of a flexible body with granular media is less understood compared with viscous fluids partially due to its complex rheological properties. In this work, we explore the effect of flexibility on granular propulsion by considering a simple mechanical model in which a rigid rod is connected to a torsional spring that is under a displacement actuation using a granular resistive force theory. Through a combined numerical and asymptotic investigation, we characterize the propulsive dynamics of such a flexible flapper in relation to the actuation amplitude and spring stiffness, and we compare these dynamics with those observed in a viscous fluid. In addition, we demonstrate that the maximum possible propulsive force can be obtained in the steady propulsion limit with a finite spring stiffness and large actuation amplitude. These results may apply to the development of synthetic locomotive systems that exploit flexibility to move through complex terrestrial media.

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