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Bio-inspired Propulsion with Functionally Graded Materials[1]
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— From an engineering perspective, biological swimmers are a composite material system with varying material properties across their propulsors. These material properties govern how the swimmer's structure interacts with its surrounding fluid. A two dimensional boundary element fluid solver is strongly coupled to a direct, implicit, geometrically non-linear structure solver to study the effects of functionally graded materials. A zeroth order functionally graded material approximation is used, where a rigid material abruptly meets a flexible material. Thrust, input power, and propulsive efficiency are studied as functions of non-dimensional frequency, reduced frequency, Strouhal number, flexion ratio, and effective stiffness. The numerical results are compared to experimental results for zero attack angle cases, building confidence in the numerical model. The results are further compared to structurally rigid materials.

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