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Numerical investigation of hydroelastic response of a three-dimensional deformable hydrofoil

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The present study is concerned with the numerical simulation of Fluid-Structure Interaction (FSI) on a deformable three-dimensional hydrofoil in a turbulent flow. The aim of this work is to develop a strongly coupled two-way fluid-structure interaction methodology with a sufficiently high spatial accuracy to examine the effect of turbulent and cavitating flow on the hydroelastic response of a flexible hydrofoil. A 3-D cantilevered hydrofoil with two degrees-of-freedom is considered to simulate the plunging and pitching motion at the foil tip due to bending and twisting deformation. The defined problem is numerically investigated by coupled Finite Volume Method (FVM) and Finite Element Method (FEM) under a two-way coupling method. In order to find a better understanding of the dynamic FSI response and stability of flexible lifting bodies, the fluid flow is modeled in the different turbulence models and cavitation conditions. The flow-induced deformation and elastic response of both rigid and flexible hydrofoils at various angles of attack are studied. The effect of three-dimension body, pressure coefficient at different locations of the hydrofoil, leading-edge and trailing-edge deformation are presented and the results show that because of elastic deformation, the angle of attack increases and it lead to higher lift and drag coefficients. In addition, the deformations are generally limited by stall condition and because of unsteady vortex shedding, the post-stall condition should be considered in FSI simulation of deformable hydrofoil. To evaluate the accuracy of the numerical model, the present results are compared and validated against published experimental data and showed good agreement.

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