Passive Vibration Damping of Hydrofoils using Resonant Piezoelectric Shunt

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ABSTRACT

Marine lifting surfaces undergo flow-induced vibrations leading to shorter life cycles due to structural fatigue and reduced acoustic performances. As such, accurate understanding of the fluid-structure response of marine structures, as well as vibrations control and damping, are critical to many maritime applications [1]. In particular, this work investigates the potential of the electromechanical coupling inherent to piezoelectric materials for passive vibration damping of hydrofoils under hydrodynamic flows [2]. A structure equipped with piezoelectric patches connected to a resonant shunt is considered.

A preliminary experimental or numerical modal analysis is required to determine the optimal patches location and design the electrical circuit. First, a finite element model is used with consideration of the fluid added mass to compute the mode shapes of the fully immersed structure. The piezoelectric patches must be placed where the structure undergoes maximum deformations relatively to the mode considered. The patches are then modelled in the finite element code, and open-circuit and closed-circuit simulations are performed. This allows the computation of the piezoelectric coupling factor related to the expected performance of the passive vibration damping strategy. Second, the values for the resistive and inductive components of the RL-shunt are inferred from the coupling factor and the natural frequencies. Passive inductors are then produced according to these specifications using copper wire and appropriate magnetic circuits [3].

The solution is first validated in air, then tested under different hydrodynamic flows. Vibrations are measured for various incidences and Reynolds numbers with and without piezoelectric coupling. Comparisons of the two configurations are realised and the resonant shunt performance for vibration reduction of hydrofoils is estimated.

REFERENCES

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