FLUTTER INSTABILITY OF PIEZOELECTRIC FLUTTERING PLATES USED AS FLOW-ENERGY HAVERSTERS

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Abstract In this work, the fluid-solid-electric coupling of piezoelectric fluttering plates in axial flows is studied experimentally and numerically. Keywords: flag flutter, energy-harvesting, piezoelectric coupling, fluid-structure interaction, instability.

Rectangular cantilevered plates are known to display large amplitude oscillations once a critical value of the flow velocity is reached, a phenomenon commonly referred to as "flag flutter" [1], which results from an instability of straight position of the plate, due to aerodynamic reactions forces. This system was the subject of a considerable number of numerical and experimental research works in the last decade [2]. Drawing profit from these oscillations to harvest kinetic energy of a flow received a growing attention recently. We are interested here in the energy harvesting potential of a cantilevered plate in a flow equipped with a distributed series of small piezoelectric elements, as sketched on Figure 1. Each of the piezoelectric pairs is connected to an energy harvesting circuit. In our work, various kinds of such circuits are considered, such as simple resistive circuits [3, 4, 5], inductive circuits [6] or active switching circuits [7]. We show how the piezoelectric coupling can modify the stability properties of the system, and present parametric studies of the efficiency of the system.

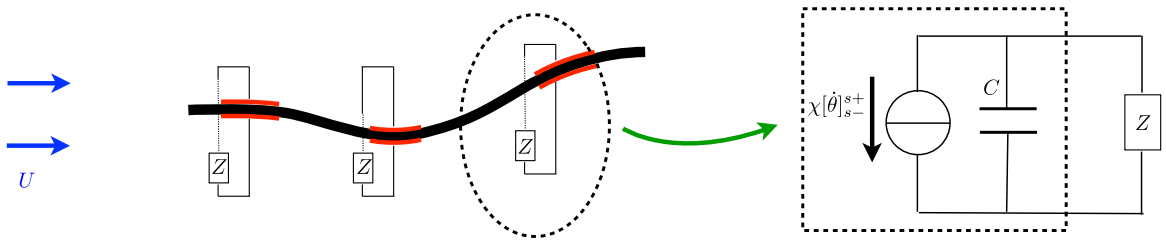

Figure 1. Schematic view of a plate in axial flow equipped with piezoelectric patches pairs.

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