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Active Perturbation on Vortex-Induced Acoustic Resonance

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Flow-induced acoustic resonance results from strong interactions between unsteady separated flows and the acoustic modes of a cavity. This work explores the feasibility of using piezoelectric-actuator-based perturbation technique in the control of vortex-induced noise through systematic experimental studies. A thick rectangular plate was used as the vortex generator and placed upstream of a cavity. Curved piezo-ceramic actuators were embedded in a slot on the top side of the plate to provide a perturbation to the flow. Uncontrolled flow-acoustic interaction was first examined to provide a baseline for comparison. Results show that noises induced by flow separation from the thick rectangular plate and the wall ahead of the cavity have very different critical flow velocities so that their effects can be well separated. Open-loop control tests indicate that vortex-induced acoustic resonance can be successfully controlled using the proposed technique. Analyses suggest that the convection of votices separated from the leading edge along the plate surface was accelerated by the surface perturbation, which interacted vigorously with the formation of the dominant trailing edge vortex, thus weakening the vortex strength in the wake of the plate. This weakened vortex strength substantially alters the flow-acoustic interaction, resulting in a significant impairment of vortex-induced acoustic resonance.
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