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EXPLOITATION OF FLOW-INDUCED SURFACE VIBRATION FOR SUPPRESSION OF CAVITY NOISE

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ABSTRACT: Flow past a rectangular open cavity captivates the aeroacoustics community with its prevalence in diverse engineering applications across low- and high-speed environments. Under certain conditions, unsteady flow over a cavity triggers self-sustained flow oscillations that resonate with internal acoustic modes, producing extremely intense tonal noise whose strong flow fluctuations risk premature mechanical failures with prolonged exposure. Existing noise reduction techniques, such as reshaping cavities or deploying plasma actuators and leading-edge blow systems, prove effective. However, they inevitably alter primary flow patterns, sparking unwanted side effects like heightened turbulence, added drag, soaring energy demands, and extraneous noise in frequency ranges absent in the original flow. The present effort explores a novel methodology of passive control for cavity tonal noise through introducing flow-induced surface vibrations at strategic locations on cavity walls. The primary objective is to suppress tonal noise while keeping the unsteady flow over the cavity opening largely intact yet minimizing any negative impact on cavity aerodynamic performance. The proposed methodology proves feasible yet effective, offering a superior alternative design for quiet, energy-efficient system development in flow-management applications for the energy and transportation industries. The details of the methodology and encouraging results are shared and discussed.

KEYWORDS: Cavity noise, flow-induced vibration, passive noise control, aeroacoustics, CE/SE method.