Abstract

The unsteady pressure and optical properties of subsonic flow over open and partially-covered rectangular cavities were investigated through a series of wind-tunnel experiments. The results revealed that when the cavity was open, the well-known “Rossiter” modes were excited, but when the cavity was partially-covered, peak frequencies arose which were lower than the Rossiter modes for a cavity of the same opening length. A new “long-path” frequency prediction formula was developed to estimate these frequencies in a manner similar to the Rossiter formula. It was also observed that when a long-path mode frequency coincided with the natural frequency of the cavity, the shear-layer motions were dominated by this resonant frequency. Phase-averaged schlieren images were used to examine the suitability of these resonant shear-layer motions for aero-optic applications. Additionally, the acquisition of time-resolved, digital schlieren images of the shear layer allowed the development of a novel form of schlieren velocimetry, which revealed that coherent optical structures in the shear layer traverse the length of the cavity at speeds lower than those presupposed by the Rossiter or long-path formulations.