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Control of Pressure Loads in Complex Cavity Configurations

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The need to reduce the fluctuating surface pressure loads in *realistic* three dimensional cavity configurations is clear for many applications. Here an experimental study was conducted to examine the effects of different leading edge blowing concepts for a highly three dimensional cavity. In addition to the suppression studies the properties of the complex cavity was studied through the use of several simpler cavities with limited features of the full three dimensional cavity. The two leading edge blowing suppression concepts examined were micro jets and segmented slots. Both of the concepts showed significant reductions in the fluctuating surface pressures with modest amounts of mass flowing through the injectors. The reductions observed in the fluctuating surface pressure levels resulted from decreases in both the broad band and resonant features of the surface pressures. Velocity field measurements showed that the controlled cavities had significantly reduced fluctuating velocities in the shear layer and a smaller amplitude reverse flow along the bottom of the cavity. The observations reported in this study have also served as a basis for designing actuators for larger scale tests where consistent results were found.

I. Introduction

The large fluctuating surface pressure loads observed in aircraft weapons and cargo bays as well as in landing gear bays represent a serious concern for many current and future aircraft. Over the past few decades numerous studies have been aimed at developing a fundamental understanding of the physical mechanisms which drive these fluctuating pressures. These studies date back to those of Krishnamurty[5] and Roshko[11] and have been the subject of many review articles such as Rockwell and Naudascher[10]. In addition there has been an abundance of studies where active and passive control methods have been attempted with the aim of reducing these dynamic loads in cavity flows. Passive approaches include: various types of spoilers at the leading edge, such as rods, saw-toothed spoilers and fences, among others. While some of these passive methods have produced significant reductions in the fluctuating pressure levels the attenuation is often in the cavity tones and is generally limited to a narrow range of operating conditions. Broadband noise reduction, over a wide range of conditions has been difficult to achieve using passive means. Active control concepts have shown promise in model scale tests and flight tests although many of the mechanism of the actuation concepts still need to be better understood. The actuation concepts have included steady and unsteady blowing, zero net mass flux actuators and piezoelectric flaps. Due to the large amount of studies

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